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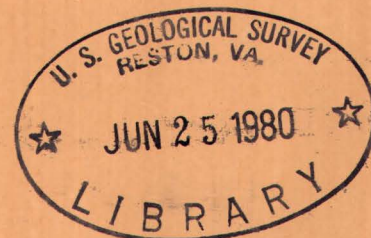
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# Stratigraphic Sections of the Phosphoria Formation in Montana, 1947-48

By R. W. Swanson, M. R. Klepper, W. R. Lowell, F. S. Honkala,  
E. R. Cressman, D. A. Bostwick, O. A. Payne, and E. T. Ruppel

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*Trace Elements Investigations Report 186*

UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

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Geology - Mineralogy

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Series A

UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION  
IN MONTANA, 1947-48\*

By

R. W. Swanson, M. R. Klepper, W. R. Lowell, F. S. Honkala,  
E. R. Cressman, D. A. Bostwick, O. A. Payne, and E. T. Ruppel

December 1952

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Trace Elements Investigations Report 186

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\*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission

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# STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION IN MONTANA, 1947-48

## INTRODUCTION

The U. S. Geological Survey has recently measured and sampled the Phosphoria formation at many localities in Montana and other western states. These data will not be fully synthesized and analyzed for several years, but segments of the data, accompanied by little or no interpretation, will be published as preliminary reports as they are assembled. This report, which contains abstracts of many of the sections measured in southwestern Montana (pl. 1), is one of this series. The field and laboratory procedures adopted in these investigations are described rather fully in a companion report (McKelvey and others, 1952).

Many people have taken part in this investigation. The program of which this work is a part was organized by V. E. McKelvey. J. G. Evans, J. E. Joyce, J. A. Kelleher, R. L. Konizeski, J. A. Mann, R. L. Parker, J. E. Smedley, L. A. Thomas, and W. H. Wilson participated in the description of strata and collection of samples referred to in this report. The laboratory preparation of samples for chemical analysis was done in Denver, Colo., under the direction of W. P. Huleatt.

All the  $P_2O_5$ , F,  $V_2O_5$ , and acid-insoluble analyses were made for the Survey by the U. S. Bureau of Mines at the Northwest Electrodevelopment Laboratory, Albany, Oreg., under the direction of S. M. Shelton and M. L. Wright. The  $Al_2O_3$ ,  $Fe_2O_3$ , and loss-on-ignition analyses were about equally distributed between the Bureau of Mines and the Trace Elements Section laboratory of the Survey in Washington, D. C., under the direction of J. C. Rabbitt by chemists I. Barlow, A. Caemmerer, J. Greene, N. Gutttag, and E. H. Humphrey. The spectrographic analyses were made by D. M. Mortimer, of the Bureau of Mines in Albany, and the oil-shale analyses were made by the Bureau of Mines Petroleum and Oil-Shale Experiment Station at Laramie, Wyo.

Compilation of the data has been largely by R. P. Sheldon and F. D. Frieske. Organization of the tabular data has been largely by Anita Cozzetto.

## Acknowledgments

Special thanks are due A. E. Weissenborn, K. P. McLaughlin, and W. B. Myers, who have given much advice and help in carrying out the field program.

The cost of the field and laboratory investigations has been borne partly by the Missouri River Basin Division of the Bureau of Reclamation and the Division of Raw Materials of the Atomic Energy Commission. Their support is gratefully acknowledged.

It is a pleasure to acknowledge the fine cooperation extended to the field parties by the local residents, property owners, and operating companies who furnished information and services and gave access to property. These include principally R. B. Shelledy,

R. J. Armstrong, and J. J. McKay of the Montana Phosphate Products Company; and William Anderson and the Martin brothers who developed the Melrose and Canyon Creek properties.

## STRATIGRAPHY OF THE PHOSPHORIA FORMATION IN MONTANA

The Phosphoria formation in southwestern Montana consists in general of five members, two phosphatic shale members and three hard members. The first description of these members (Klepper and others, 1948) was presented in a paper read at the Northwest Science meetings in Spokane, Wash., in 1948, but the first published description was by Klepper (1950). The lower two hard members are dominated by limestone and the top by chert and sandstone or quartzite. Most of the members can be identified over a large part of the area of outcrop, though member correlation toward the east and northeast is much more difficult. The formation ranges in thickness from less than 100 feet to more than 800 feet.

The lowermost or A member is best developed toward the west and southwest and consists of limestone or dolomite, sandstone, mudstone, and chert, with a maximum thickness of nearly 350 feet. It overlies the Pennsylvanian Quadrant formation and is probably equivalent to the upper member of the Wells formation of southeastern Idaho and adjacent Wyoming and Utah (McKelvey, 1949).

The lower phosphatic shale or B member is about 50 feet thick near the southwest corner of the state but thins markedly to the north and east where in some areas it cannot be recognized. It contains a rich bed of minable phosphate in the Centennial Range.

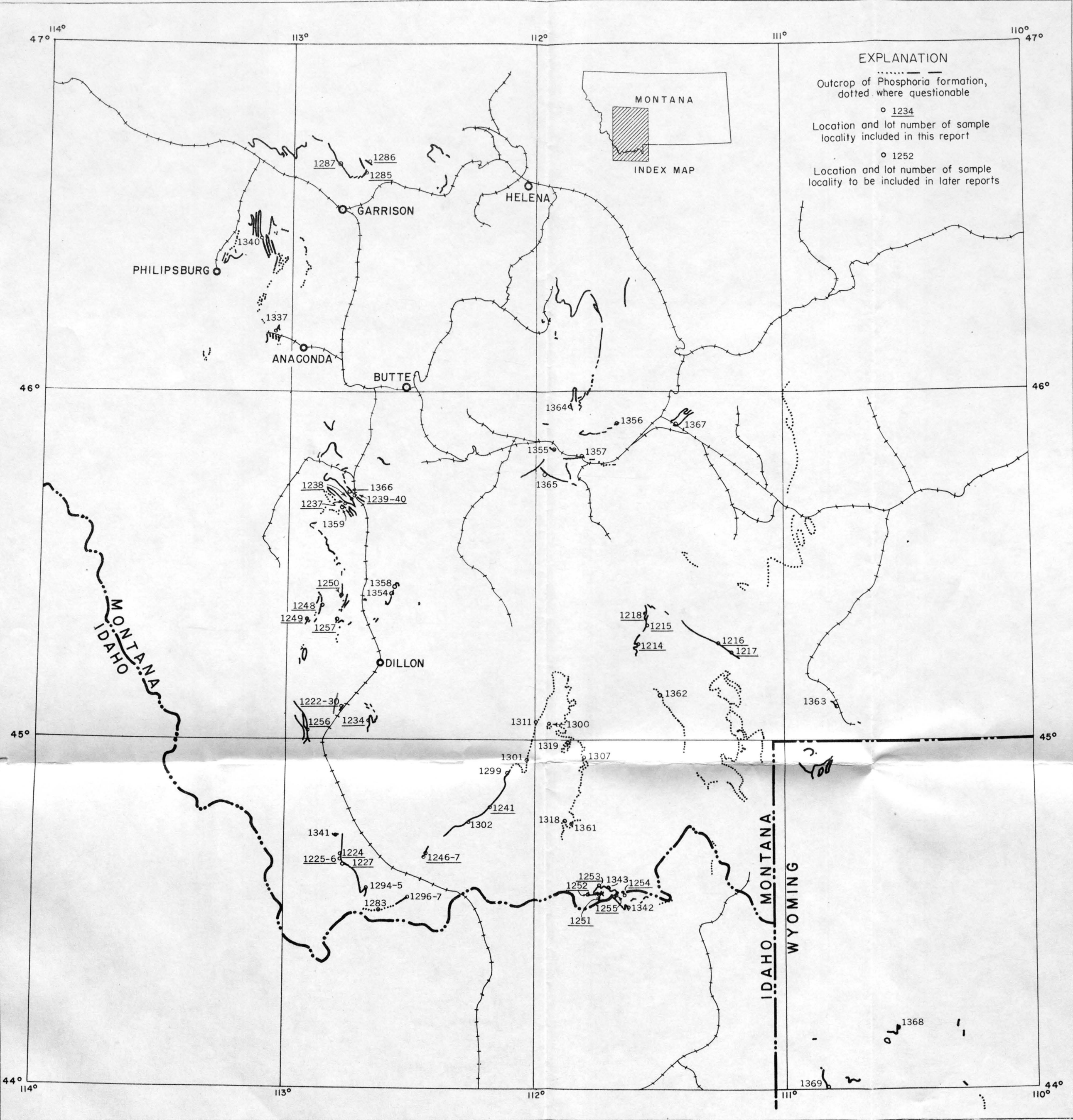
The middle or C member consists of as much as 200 feet of limestone and/or chert and sandstone. The upper phosphatic shale or D member is rather similar to and much more uniform and widespread than the B member, though minable phosphate is present only toward the north end of the field where the full thickness of the phosphatic zone consists in some places of a single 3- to 5-foot bed of high-grade phosphate rock.

The uppermost or E member is the most widespread and uniform, averaging about 100 feet in thickness and consisting chiefly of siliceous rocks—siltstone, chert, and quartzitic sandstone. It is overlain by the Triassic Dinwoody formation in the greater part of the area and by the Jurassic Ellis group toward the north and northeast.

## STRATIGRAPHIC SECTIONS

Analytical data and abstracts of stratigraphic sections measured at 26 localities follow. Their locations as well as the locations of other sections to be reported later are shown in plate 1.







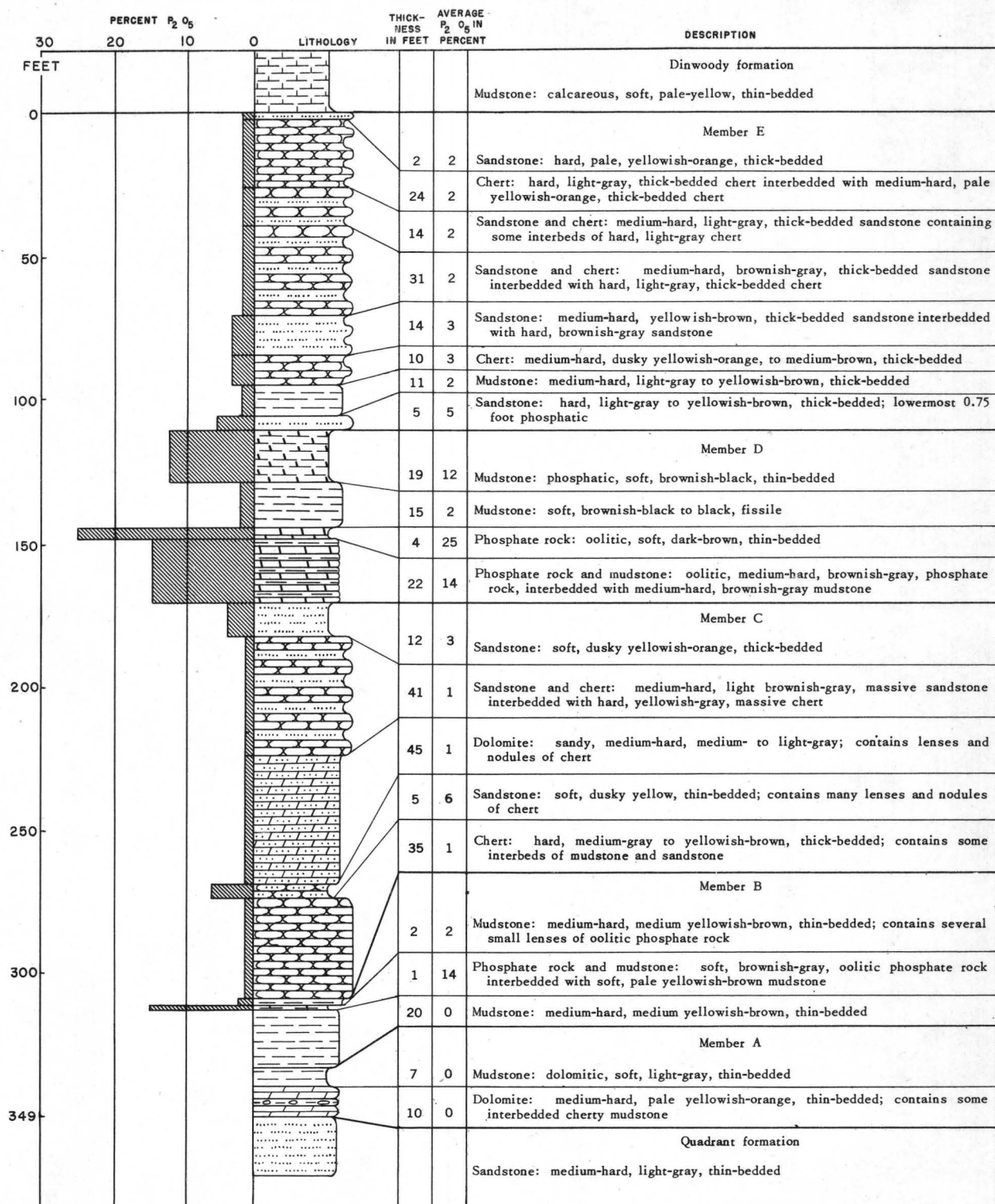


Figure 1.--Generalized section of Phosphoria formation at Sheep Creek, Montana

The semiquantitative spectrographic analyses are based upon comparisons with a standard plate representing known quantities of the elements tested for and made at the same exposure. Greater sensitivities for many elements can be obtained by additional exposures. The standard sensitivities for the elements noted in this report are as follows:

Element	Percent	Element	Percent
Al .....	0.005	Li .....	0.2
Sb .....	.05	Mg .....	.001
As .....	.1	Mn .....	.004
Ba .....	.08	Hg .....	.10
Be .....	.001	Mo .....	.004
Bi .....	.002	Ni .....	.01
B .....	.001	P .....	.8
Cd .....	.1	Pt .....	.01
Ca .....	.01	Si .....	.002
Cr .....	.02	Ag .....	.001
Co .....	.01	Na .....	.05
Cb .....	.01	Sr .....	.1
Cu .....	.001	Ta .....	1.0
Ga .....	.05	Sn .....	.01
Ge .....	.01	Ti .....	.002
Au .....	.01	W .....	.1
In .....	.05	V .....	.01
Fe .....	.005	Zn .....	.05
Pb .....	.1	Zr .....	.003

## REFERENCES

Klepper, M. R., Lowell, W. R., Myers, W. B., Swanson, Roger W., and Kennedy, George C., 1948, Distribution and stratigraphy of the Phosphoria formation in southwestern Montana, paper read at Northwest Science meeting, Spokane, Wash., in December 1948.

Klepper, M. R., 1950, A geologic reconnaissance of parts of Beaverhead and Madison Counties, Montana: U. S. Geol. Survey Bull. 969-C.

McKelvey, V. E., 1949, Geological studies of the western phosphate field: Am. Inst. Min. Met. Eng. Mining Trans., vol. 184, pp. 270-279.

McKelvey, V. E., Davidson, D. F., Sheldon, R. P., Hoppin, R. A., Campbell, R. M., and Weeks, R. A., 1952, Stratigraphic sections of the Phosphoria formation in Idaho: U. S. Geol. Survey Circular 208. ~~TEI-183~~



ANDERSON MINE, MONTANA. LOT NO. 1287.

D member of Phosphoria formation sampled at 4,800 level of Anderson mine of Montana Phosphate Products Company, secs. 2 and 3, T. 10 N., R. 10 W., Powell County, Montana, on southwest flank of Garrison anticline, samples 308-313, locality A, from 100 feet south of north heading and sample 314, locality B, from 150 feet south of crosscut. Beds strike about N. 30° W., and dip 30° SW. Section measured and sampled by M. R. Klepper in October 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Locality A, 4,800 level, 100 feet south of north heading										
E member of Phosphoria formation—basal beds only										
E-2	Quartzite	--	1.0	--	--	1.0	--	--	--	--
E-1	Conglomerate	--	0.5	--	--	1.5	--	--	--	--
D member of Phosphoria formation										
D-8	Clay	--	0.02	--	--	0.02	--	--	--	--
D-7	Phosphate rock, argillaceous	MRK-313	0.75	27.8	25.6	0.77	20.85*	.010	.008	.006*
D-6	Phosphate rock	MRK-312	0.7	37.5	4.5	1.47	40.31	.012	.010	.013
D-5	Phosphate rock	MRK-311	0.5	36.4	7.3	1.97	58.51	.012	.010	.018
D-4	Phosphate rock	MRK-310	0.9	32.5	15.1	2.87	87.76	.011	.009	.026
D-3	Phosphate rock	MRK-309	1.0	36.6	5.9	3.87	124.36	.013	.011	.037
D-2	Phosphate rock	MRK-308	0.9	31.1	14.7	4.77	152.35**	.012	.011	.047**
D-1	Clay	--	0.15	--	--	4.92	--	--	--	--
C member of Phosphoria formation—top beds only										
C-2	Conglomerate	--	1.0	--	--	1.0	--	--	--	--
C-1	Sandstone	--	2.0	--	--	3.0	--	--	--	--
Locality B, 4,800 level, 150 feet south of crosscut										
E member of Phosphoria formation—not measured										
E-1	Chert	--	--	--	--	--	--	--	--	--

\* Cumulative data incomplete due to missing information.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				$P_2O_5$	Acid insoluble			eU	Chem. U	
D member of Phosphoria formation										
D-1	Phosphate rock	MRK-314	4.3	32.8	12.8	--	--	.013	.011	--
	Composite sample representing beds D-2 to D-7 of locality A.									
C member of Phosphoria formation—top beds only										
C-4	Quartzite	--	0.3	--	--	0.3	--	--	--	--
C-3	Conglomerate	--	0.9	--	--	1.2	--	--	--	--
C-2	Clay	--	0.2	--	--	1.4	--	--	--	--
C-1	Sandstone and chert	--	2.0	--	--	3.4	--	--	--	--



GRAVELEY MINE, MONTANA. LOT NO. 1286.

D member of Phosphoria formation sampled in Graveley Mine of Montana Phosphate Products Company, sec. 2, T. 10 N., R. 9 W., Powell County, Montana, on northeast side of Luke-Graveley syncline; samples 297-299, locality A, from 4,906 stope and samples 300-303, locality B, from 5,101 west heading. Beds strike about N. 70° W. and dip 50° S. Section measured and sampled by M. R. Klepper in September 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Locality A, 4,906 stope										
E member of Phosphoria formation—not measured										
E-1	Chert	--	--	--	--	--	--	--	--	--
D member of Phosphoria formation										
D-5	Clay	--	0.05	--	--	0.05	--	--	--	--
D-4	Phosphate rock	MRK-299	1.3	35.0	10.2	1.35	45.50*	.016	.010	.013*
D-3	Phosphate rock	MRK-298	1.0	37.5	8.4	2.35	83.00	.015	.010	.023
D-2	Phosphate rock	MRK-297	1.25	37.4	4.6	3.60	129.75**	.014	.010	.036**
D-1	Clay	--	0.1	--	--	3.70	--	--	--	--
C member of Phosphoria formation—not measured										
C-1	Quartzite	--	--	--	--	--	--	--	--	--
Locality B, 5,101 west heading										
E member of Phosphoria formation—not measured										
E-1	Chert	--	--	--	--	--	--	--	--	--
D member of Phosphoria formation										
D-5	Clay	--	0.05	--	--	0.05	--	--	--	--
D-4	Phosphate rock	MRK-303	1.2	36.8	6.2	1.25	44.16*	.016	.014	.017*
D-3	Phosphate rock	MRK 302	1.0	37.5	3.9	2.25	81.66	.014	.015	.032
D-2	Phosphate rock	MRK-301	0.8	34.4	4.1	3.05	109.18**	.015	.010	.040**
D-1	Clay	--	0.05	--	--	3.10	--	--	--	--

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.

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Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
C member of Phosphoria formation—top beds only										
C-3	Conglomerate	MRK-300	1.0	5.4	81.2	1.0	--	--	--	--
C-2	Sandstone	--	1.5	--	--	2.5	--	--	--	--
C-1	Quartzite	--	--	--	--	--	--	--	--	--



LUKE MINE, MONTANA. LOT NO. 1285.

D member of Phosphoria formation sampled in Luke Mine of Montana Phosphate Products Company, sec. 15, T. 10 N., R. 9 W., Powell County, Montana, on southwest side of Luke-Graveley syncline; samples 304-305, locality A, from southeast heading, 5,300 level, samples 306-307, locality B, from northwest heading, 5,300 level. Beds strike about N. 40° W. and dip 45° NE. Section measured and sampled by M. R. Klepper in September 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Locality A, 5,300 level, southeast heading										
E member of Phosphoria formation—basal bed only										
E-1	Quartzite, cherty	--	4.0	--	--	--	--	--	--	--
D member of Phosphoria formation										
D-4	Clay	--	0.02	--	--	0.02	--	--	--	--
D-3	Phosphate rock	MRK-305	1.6	34.0	9.3	1.62	54.4	.012	.009	.014
D-2	Phosphate rock	MRK-304	1.6	35.5	5.8	3.22	111.2**	.012	.010	.030**
D-1	Clay	--	0.1	--	--	3.32	--	--	--	--
C member of Phosphoria formation—top beds only										
C-2	Quartzite	--	2.0	--	--	--	--	--	--	--
C-1	Quartzite	--	4.0	--	--	--	--	--	--	--
Locality B, 5,300 level, northwest heading										
E member of Phosphoria formation—basal bed only										
E-1	Quartzite	--	1.5	--	--	--	--	--	--	--
D member of Phosphoria formation										
D-2	Phosphate rock	MRK-307	1.6	33.1	9.8	1.6	52.96	.014	.008	.013
D-1	Phosphate rock	MRK-306	1.6	36.7	4.1	3.2	111.68	.013	.011	.030
C member of Phosphoria formation—top beds only										
C-3	Quartzite	--	0.3	--	--	0.3	--	--	--	--
C-2	Conglomerate	--	0.5	--	--	0.8	--	--	--	--
C-1	Chert	--	2.0	--	--	2.8	--	--	--	--

\*\* Note incompleteness of cumulative data.

## CANYON CREEK NO. 1, MONTANA. LOT NO. 1237.

D member of Phosphoria formation sampled in hand trench near Canyon Creek, SE $\frac{1}{4}$  sec. 12, T. 2 S., R. 10 W., Beaverhead County, Montana, on west limb of an overturned anticline. Beds strike N. 60° W. and dip 50° SW. Section measured by M. R. Klepper and sampled by E. T. Ruppel in September 1948. Samples analyzed for  $P_2O_5$  and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—basal bed only													
E-1	Chert	MRK-270	1.0	7.2	--	--	--	77.0	1.0	7.2	.002	.002	.002
D member of Phosphoria formation—base not exposed													
D-5	Phosphate rock	MRK-269	1.0	34.7	1.3	2.57	1.64	7.2	1.0	34.70	.007	.007	.007
D-4	Mudstone, calcareous, and phosphate rock	MRK-268	1.4	10.1	9.7	8.74	6.72	47.8	2.4	48.84	.005	.003	.011
D-3	Phosphate rock	MRK-267	1.8	34.6	2.6	2.40	3.60	6.1	4.2	111.12	.009	.010	.029
D-2	Mudstone and phosphate rock	MRK-266	1.0	16.3	8.5	5.38	7.74	39.3	5.2	127.42	.006	.006	.035
D-1	Mudstone, phosphatic	MRK-265	6.0	19.6	7.9	2.34	7.06	38.7	11.2	245.02	.007	.007	.077

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## CANYON CREEK NO. 2, MONTANA. LOT NO. 1238.

D member of Phosphoria formation sampled in hand trench near Canyon Creek, E $\frac{1}{2}$ SE $\frac{1}{4}$  sec. 6, T. 2 S., R. 9 W., Beaverhead County, Montana, on overturned east limb of an anticline. Beds strike N. 5-10° W. and dip 70° W. Section measured by M. R. Klepper and sampled by E. T. Ruppel in September 1948. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—basal bed only													
E-1	Quartzite and conglomerate	--	--	--	--	--	--	--	--	--	--	--	--
D member of Phosphoria formation—base not exposed													
D-4	Mudstone	--	0.2	--	--	--	--	--	0.2	--	--	--	--
D-3	Phosphate rock and mudstone	MRK-273	3.0	19.1	--	--	--	43.2	3.2	57.30*	.005	.003	.009*
D-2	Phosphate rock and mudstone	MRK-272	3.8	19.1	--	--	--	35.0	7.0	129.88	.005	.005	.028
D-1	Phosphate rock	MRK-271	3.0	30.8	1.1	0.90	7.08	7.1	10.0	222.28**	.007	.007	.049**

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.



## MELROSE ADIT NO. 2, MONTANA. LOT NO. 1239.

D member of Phosphoria formation sampled in an adit of the Anderson Phosphate Mines, Incorporated, of Butte, Montana, known as the Melrose Property, in NW $\frac{1}{4}$  sec. 5, T. 2 S., R. 9 W., Silverbow County, Montana, on the normal limb of a northwest-trending overturned syncline. Beds D-6 through D-11 sampled at heading of a south-southeast drift approximately 1,400 feet from portal; beds D-1 through D-5 sampled 36 feet from heading. Beds strike northwest and dip 45° SW. Section measured by M. R. Klepper and O. A. Payne and sampled by Payne in September 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)						Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	F	Loss on ignition	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—basal bed only														
E- 1	Chert and conglomerate	--	--	--	--	--	--	--	--	--	--	--	--	--
D member of Phosphoria formation														
D-11	Mudstone		0.2	--	--	--	--	--	--	0.2	--	--	--	--
D-10	Phosphate rock, argillaceous	MRK-293	1.25	23.9	2.2	2.6	2.14	1.5	32.6	1.45	29.90*	.004	.003	.004*
D- 9	Phosphate rock and calcareous mudstone	MRK-292	0.6	27.5	6.3	2.5	2.75	2.8	16.0	2.05	46.40	.006	.003	.006
D- 8	Phosphate rock	MRK-291	0.85	33.3	1.9	1.4	3.05	1.8	10.1	2.90	74.40	.007	.006	.011
D- 7	Mudstone	MRK-290	1.4	3.8	13.0	5.6	0.71	4.3	61.7	4.30	79.72	.003	.002	.013
D- 6	Phosphate rock	MRK-289	1.9	36.4	1.1	1.1	3.28	1.6	4.8	6.20	148.88	.006	.005	.023
D- 5	Mudstone, calcareous	MRK-288	0.4	4.4	10.4	10.0	2.40	6.2	39.9	6.60	150.64	.005	.003	.024
D- 4	Phosphate rock	MRK-287	0.6	31.2	3.2	2.0	2.78	2.2	15.3	7.20	169.36	.005	.002	.025
D- 3	Mudstone and phosphate rock	MRK-286	1.2	26.2	4.9	2.1	2.3	2.7	24.5	8.40	200.80	.007	.003	.029
D- 2	Phosphate rock	MRK-285	0.9	35.2	1.8	1.3	3.16	2.2	7.5	9.30	232.48	.005	.004	.033
D- 1	Phosphate rock, argillaceous	MRK-284	3.0	23.8	5.9	2.5	2.1	4.6	28.8	12.30	303.88**	.005	.004	.045**

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.

**SPECTROGRAPHIC ANALYSES—MELROSE ADIT NO. 2, MONTANA. LOT NO. 1239.**

Semi-quantitative analyses of samples of the D member of Phosphoria formation, Melrose adit no. 2, Montana (see immediately preceding page for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Bureau of Mines Laboratory, Albany, Oregon. In addition to the elements listed in the table below, Sb, As, Ba, Be, Bi, Cd, Co, Cb, Ga, Ge, Au, In, Pb, Li, Hg, Pt, Ta, Sn, and W were looked for in all samples but were not detected.

**Explanation of symbols**

A = more than 10 percent	E = 0.01-0.1 percent
B = 5-10 percent	F = 0.001-0.01 percent
C = 1-5 percent	G = less than 0.001 percent
D = 0.1-1 percent	

Bed no.	Sample no.	Al	B	Ca	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Si	Ag	Na	Sr	Ti	V	Zn	Zr
D-11	MRK-294	B	E	C	D	F	A	C	E	F	E	A	G	E	F	C	D	E	E
D-10	MRK-293	C	F	A	E	G	C	C	E	F	E	B	G	E	E	E	E	E	E
D-9	MRK-292	B	F	A	E	G	C	C	E	F	E	B	G	E	E	D	E	E	E
D-8	MRK-291	C	F	A	E	G	C	C	E	F	E	A	G	E	E	E	E	E	E
D-7	MRK-290	B	E	B	E	G	A	C	E	F	E	A	G	E	F	D	E	E	E
D-6	MRK-289	C	F	A	E	G	C	D	E	F	E	C	G	E	E	E	D	E	E
D-5	MRK-288	B	F	A	D	G	A	A	E	E	D	A	G	E	F	D	D	E	E
D-4	MRK-287	B	F	A	E	G	C	C	F	F	E	A	F	E	E	D	D	E	E
D-3	MRK-286	B	F	A	E	G	C	C	F	F	E	A	F	E	E	D	D	E	E
D-2	MRK-285	C	F	A	E	G	C	D	F	F	E	C	G	E	E	E	D	E	E
D-1	MRK-284	B	F	A	D	G	C	C	F	F	E	A	G	E	E	D	D	E	E

MELROSE ADIT NO. 1, MONTANA. LOT NO. 1240.

D member of Phosphoria formation sampled in southwest crosscut 269 feet from portal of the Anderson Phosphate Mines, Incorporated, of Butte, Montana, known as the Melrose Property, NW $\frac{1}{4}$  sec. 5, T. 2 S., R. 9 W., Silver Bow County, Montana, on normal limb of overturned syncline. Beds strike northwest and dip 45° SW. Section measured by M. R. Klepper and O. A. Payne and sampled by Payne in September 1948. Samples analyzed for  $P_2O_5$  and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	Loss on ignition	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—basal bed only													
E- 1	Chert	--	--	--	--	--	--	--	--	--	--	--	--
D member of Phosphoria formation													
D-10	Conglomerate and phosphate rock	MRK-283	0.5	27.4	1.6	2.09	2.04	25.0	0.5	13.70	.008	.005	.003
D- 9	Mudstone	MRK-282	0.2	5.4	9.5	7.05	4.26	66.6	0.7	14.78	.003	.002	.003
D- 8	Phosphate rock	MRK-281	1.6	29.1	2.7	2.37	2.16	18.6	2.3	61.34	.006	.001	.005
D- 7	Mudstone	--	0.15	--	--	--	--	--	2.45	--	--	--	--
D- 6	Phosphate rock, argillaceous	MRK-280	0.8	24.1	5.4	2.96	2.56	29.4	3.25	19.28*	.005	.003	.002*
D- 5	Mudstone	MRK-279	1.2	1.1	13.00	6.29	4.68	76.6	4.45	20.60	.002	.001	.004
D- 4	Phosphate rock	MRK-278	2.1	28.4	1.5	1.55	1.68	6.4	6.55	80.24	.007	.003	.010
D- 3	Phosphate rock	MRK-277	1.0	27.6	4.9	2.51	3.50	19.5	7.55	107.84	.005	.003	.013
D- 2	Phosphate rock	MRK-276	3.9	32.0	1.4	1.39	2.70	14.3	11.45	232.64**	.006	.002	.021**
Base of D-2 is a gougy fault zone of several strands cutting dark mudstone and phosphate rock.													
D- 1	Phosphate rock, argillaceous	MRK-275	9.0	15.8	--	--	--	33.7	--	--	.005	.003	--
C member of Phosphoria formation—top bed only													
C- 1	Dolomite and chert	--	--	--	--	--	--	--	--	--	--	--	--

\* Cumulative data incomplete due to missing information. Computations start from zero after interruption.

\*\* Note incompleteness of cumulative data.

RESTRICTED



## SOUTH GREENSTONE GULCH, MONTANA. LOT NO. 1250.

D member of Phosphoria formation sampled in south bulldozer trench at Greenstone Gulch, SE $\frac{1}{4}$  sec. 11, T. 5 S., R. 10 W., Beaverhead County, Montana. Beds strike N. 10° W. and dip 50° NE. The stratigraphic sequence of the units is questionable for, because of a large number of faults, some of the beds may be omitted or repeated. Section measured and sampled by R. L. Parker and E. R. Cressman in August 1948. Samples analysed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analysed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation--basal bed only										
E- 1	Quartzite	ERC-446	2.2?	0.4	92.2	2.2	0.88	.004	--	.009
D member of Phosphoria formation										
D-37	Mudstone	ERC-445	3.6	3.7	51.9	3.6	13.32	.002	--	.007
D-36	Mudstone	RLP-444	3.2	1.1	72.9	6.8	16.84	.003	--	.017
D-35	Mudstone	RLP-443	2.5	0.9	76.4	9.3	19.09	.003	--	.024
D-34	Mudstone	RLP-442	5.0	1.1	77.5	14.3	24.59	.003	--	.039
D-33	Mudstone, calcareous	RLP-441	1.4	6.2	58.6	15.7	33.27	.005	.002	.046
D-32	Mudstone, calcareous, phosphatic	RLP-440	2.0	9.2	50.5	17.7	51.67	.003	--	.052
D-31	Mudstone, phosphatic	ERC-439	1.4	9.8	53.4	19.1	65.39	.004	--	.058
D-30	Phosphate rock	ERC-260	0.9	24.4	17.8	20.0	87.35	.005	.003	.062
D-29	Mudstone, phosphatic	ERC-259	0.9	15.4	46.0	20.9	101.21	.004	--	.066
D-28	Mudstone	ERC-258	1.3	3.6	72.2	22.2	105.89	.003	--	.070
D-27	Mudstone, phosphatic	ERC-257	2.2	9.8	54.7	24.4	127.45	.003	--	.076
D-26	Mudstone, calcareous	ERC-256	4.1	3.3	59.8	28.5	140.98	.003	--	.089
D-25	Mudstone, calcareous	ERC-255	2.1	1.9	45.1	30.6	144.97	.008	.001	.106
D-24	Limestone, argillaceous	ERC-254	1.1	6.5	38.4	31.7	152.12	.003	--	.109
D-23	Mudstone, calcareous, and phosphatic mudstone	ERC-253	1.6	5.3	53.2	33.3	160.60	.004	--	.115
D-22	Mudstone and phosphate rock	RLP-252	1.0	17.2	35.8	34.3	177.80	.004	--	.119
D-21	Mudstone and phosphate rock	RLP-251	0.8?	10.2	57.8	35.1	185.96	.004	--	.122
D-20	Mudstone	RLP-250	1.4	5.9	69.0	36.5	194.22	.004	--	.128
D-19	Phosphate rock	RLP-249	0.7	29.4	14.3	37.2	214.80	.007	.005	.133
D-18	Phosphate rock and mudstone	RLP-248	1.05	21.4	32.0	38.25	237.05	.006	.004	.139
D-17	Phosphate rock, argillaceous	RLP-247	1.1	21.6	30.2	39.35	260.81	.006	.004	.146
D-16	Phosphate rock and mudstone, cherty	RLP-246	1.6	12.3	52.7	40.95	280.49	.004	--	.152
D-15	Mudstone, calcareous, and calcareous phosphate rock	RLP-245	0.7	15.2	25.8	41.65	291.13	.004	--	.155
D-14	Limestone	RLP-244	1.3	2.5	5.5	42.95	294.38	.0005	--	.156
D-13	Phosphate rock and mudstone	RLP-243	2.0	24.6	26.2	44.95	343.58	.004	--	.164
D-12	Mudstone, phosphatic	RLP-242	1.0	14.9	44.8	45.95	358.48	.004	--	.168

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
D-11	Limestone	RLP-241	1.0	1.2	17.5	46.95	359.68	.001	--	.169
D-10	Phosphate rock and mudstone, cherty	RLP-240	0.8	18.5	39.1	47.75	374.48	.005	.003	.173
D-9	Mudstone, phosphatic, calcareous	RLP-239	1.3	11.7	46.3	49.05	389.69	.007	.002	.182
D-8	Limestone, argillaceous, phosphatic	ERC-238	0.95	11.7	31.0	50.00	400.81	.003	--	.185
D-7	Mudstone, phosphatic	ERC-237	2.8	15.7	41.7	52.80	444.77	.006	.003	.202
D-6	Mudstone, calcareous	ERC-236	2.6	5.5	58.6	55.40	459.07	.005	.002	.207
D-5	Mudstone, phosphatic	ERC-235	3.1	11.3	52.0	58.50	494.10	.004	--	.219
D-4	Limestone, argillaceous, phosphatic	ERC-234	1.3	9.5	36.1	59.80	506.45	.004	--	.224
D-3	Phosphate rock, argillaceous	RLP-233	1.4	20.1	25.5	61.20	534.59	.003	--	.228
D-2	Phosphate rock and mudstone, cherty	RLP-232	0.9	13.7	58.9	62.10	546.92	.004	--	.232
D-1	Chert, phosphatic	RLP-231	2.0	13.4	60.3	64.10	573.72	.004	--	.240
C member of Phosphoria formation—top bed only										
C-1	Mudstone, calcareous	RLP-230	1.0	1.5	67.9	1.0	1.50	.000	--	--

## UPPER FRENCH CREEK, MONTANA. LOT NO. 1248.

D member of Phosphoria formation sampled in bulldozer trench near Upper French Creek, SW $\frac{1}{4}$  sec. 19, T. 5 S., R. 10 W., Beaverhead County, Montana. Beds strike N. 15° E. and dip 55° W. The stratigraphic sequence and thicknesses of the units are questionable due to thrust faulting exposed in the trench and to the fragmented and weathered condition of the strata. Section measured by D. A. Bostwick and R. L. Parker and sampled by R. L. Konizeski and J. E. Joyce in August 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent) eU	Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble				
D member of Phosphoria formation—top not exposed									
D-10	Phosphate rock, argillaceous	RLP-172	1.0	20.4	35.7	1.0	20.40	.004	.004
D-9	Mudstone, phosphatic	RLP-171	1.3	11.3	51.0	2.3	35.09	.004	.009
D-8	Phosphate rock and mudstone	RLP-170	1.0	19.1	37.2	3.3	54.19	.003	.012
D-7	Phosphate rock and mudstone, cherty	RLP-169	1.7	16.0	43.1	5.0	81.39	.004	.019
D-6	Mudstone	RLP-168	0.7	0.9	66.6	5.7	82.02	.004	.022
D-5	Mudstone	RLP-167	1.6	2.0	79.6	7.3	85.22	.003	.027
D-4	Mudstone	DAB-166	0.9	2.8	66.6	8.2	87.74	.003	.029
D-3	Mudstone	DAB-165	2.9	2.7	72.5	11.1	95.57	.003	.038
D-2	Mudstone, calcareous	DAB-164	1.8	3.6	71.0	12.9	102.05	.003	.043
D-1	Mudstone, calcareous	DAB-163	1.6	4.3	72.6	14.5	108.93	.003	.048
Probable fault; units below may be part of a fault zone.									
C member? of Phosphoria formation—top and base not exposed									
C-5	Quartzite and chert	DAB-162	?	1.6	85.8	--	--	.001	--
C-4	Quartzite and chert	DAB-161	?	1.5	85.3	--	--	.001	--
C-3	Quartzite and chert	DAB-160	1.5?	2.3	81.2	--	--	.001	--
C-2	Chert	DAB-159	2.2	0.5	93.1	--	--	.0005	--
C-1	Sandstone and chert	DAB-158	2.0	0.3	94.9	--	--	.000	--
Thrust fault									
Quadrant formation—not measured									
Cq-1	Quartzite	--	--	--	--	--	--	--	--



KELLEY GULCH, MONTANA. LOT NO. 1249.

A, B, D, and part of E members of Phosphoria formation sampled in bulldozer trenches and C member measured in outcrops near Kelley Gulch, sec. 2, T. 6 S., R. 11 W., Beaverhead County, Montana. A dacitic? sill 2.7 feet thick occurs 2.1 feet above base of E member. Beds strike N. 25° E. and dip 45° NW. Section measured by R. L. Parker and D. A. Bostwick and sampled by R. L. Konizeski, J. E. Joyce, Bostwick, J. A. Kelleher, and E. T. Ruppel in August 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation—not exposed										
E member of Phosphoria formation—top contact approximately located										
E- 9	Chert	--	23.0	--	--	23.0	--	--	--	--
E- 8	Chert	--	25.0	--	--	48.0	--	--	--	--
E- 7	Chert	--	25.0	--	--	73.0	--	--	--	--
E- 6	Chert	--	25.0	--	--	98.0	--	--	--	--
E- 5	Chert, sandy?	--	29.0	--	--	127.0	--	--	--	--
E- 4	Mudstone	DAB-229	4.5	0.3	85.7	131.5	1.35	.002	--	.009
E- 3	Chert	DAB-228	2.6	1.2	91.4	134.1	4.47	.0005	--	.010
E- 2	Chert	DAB-227	7.4	1.4	90.7	141.5	14.83	.0005	--	.014
--	Dacitic? dike	DAB-226	(2.7)	0.5	85.9	--	--	.002	--	--
E- 1	Chert	DAB-225	2.1	1.8	89.9	143.6	18.61	.003	--	.020
D member of Phosphoria formation										
D-38	Chert; fos. col. no. 48-KPM-51 <sup>1</sup>	DAB-224	3.4	5.6	69.3	3.4	19.04	.003	--	.010
D-37	Phosphate rock, cherty and mudstone	RLP-223	0.9	21.9	36.4	4.3	38.75	.004	--	.014
Fault zone; includes gougy streaks and crushed phosphate.										
D-36	Fault gouge and breccia	RLP-222	3.0	2.1	74.2	7.3	45.05	.003	--	.023
D-35	Mudstone	RLP-221	1.3	4.4	76.5	8.6	50.77	.003	--	.027
D-34	Phosphate rock, cherty	RLP-220	1.1	22.9	34.6	9.7	75.96	.007	.005	.034
D-33	Mudstone and phosphate rock	RLP-219	0.8	6.3	62.5	10.5	81.00	.006	.003	.039
D-32	Mudstone	RLP-218	1.3	2.3	72.7	11.8	83.90	.004	--	.044
D-31	Mudstone	DAB-217	7.0	1.8	82.9	18.8	96.59	.002	--	.058
D-30	Mudstone	DAB-216	5.0	0.7	86.2	23.8	100.09	.002	--	.068
D-29	Mudstone	DAB-215	5.0	0.7	89.3	28.8	103.59	.002	--	.078
D-28	Mudstone	DAB-214	5.0	0.7	90.0	33.8	107.09	.002	--	.088
D-27	Mudstone	DAB-213	5.0	0.6	89.3	38.8	110.09	.004	--	.108
D-26	Mudstone	DAB-212	5.0	1.3	88.5	43.8	116.59	.002	--	.118

D-25	Mudstone	DAB-211	5.0	0.9	87.5	48.8	121.09	.002	--	.128
D-24	Mudstone	DAB-210	5.0	2.3	83.1	53.8	132.59	.002	--	.138
D-23	Mudstone and phosphate rock	DAB-209	2.2	9.8	58.0	56.0	154.15	.004	--	.147
D-22	Mudstone, calcareous	DAB-208	3.6	4.5	65.5	59.6	170.35	.004	--	.162
D-21	Dolomite, phosphatic	DAB-207	2.8	11.0	6.8	62.4	201.15	.002	--	.167
D-20	Phosphate rock	DAB-206	0.6	24.3	9.3	63.0	215.73	.003	--	.169
D-19	Limestone	DAB-205	1.1	6.7	11.6	64.1	223.10	.001	--	.170
D-18	Phosphate rock and dolomite	DAB-204	0.7	9.7	19.2	64.8	229.89	.003	--	.172
D-17	Limestone	DAB-203	1.3	2.6	6.1	66.1	233.27	.0005	--	.173
D-16	Mudstone, phosphatic, calcareous	DAB-202	0.9	11.9	39.2	67.0	243.98	.003	--	.176
D-15	Phosphate rock, argillaceous; fos. col. no. 48-KPM-50	DAB-201	0.9	22.5	30.5	67.9	264.23	.006	.004	.181
D-14	Mudstone, phosphatic	DAB-200	0.9	8.9	62.5	68.8	272.24	.003	--	.184
D-13	Phosphate rock, argillaceous	RLP-199	0.7	19.4	36.5	69.5	285.82	.003	--	.186
D-12	Phosphate rock, argillaceous	RLP-198	1.7	18.0	38.8	71.2	316.42	.004	--	.193
D-11	Mudstone, phosphatic	RLP-197	1.2	16.6	42.9	72.4	336.34	.004	--	.197
D-10	Mudstone, phosphatic	RLP-196	1.5	9.5	57.8	73.9	350.59	.004	--	.203
D-9	Mudstone	RLP-195	0.6	5.2	70.6	74.5	353.71	.005	.001	.206
D-8	Mudstone, phosphatic	RLP-194	2.4	10.4	50.0	76.9	378.67	.004	--	.216
D-7	Limestone, argillaceous	RLP-193	1.7	1.8	20.7	78.6	381.73	.0005	--	.217
D-6	Mudstone	RLP-192	0.9	7.2	58.8	79.5	388.21	.003	--	.220
D-5	Mudstone, cherty	RLP-191	3.0	6.4	62.9	82.5	407.41	.003	--	.228
D-4	Mudstone, phosphatic	RLP-190	1.7	13.2	49.9	84.2	429.85	.003	--	.234
D-3	Mudstone, phosphatic	RLP-189	1.4	9.3	59.6	85.6	442.97	.003	--	.238
D-2	Mudstone, cherty	RLP-188	2.7	7.2	61.8	88.3	462.31	.003	--	.246
D-1	Mudstone, phosphatic, cherty	DAB-187	1.4	13.8	52.7	89.7	481.63	.006	.005	.254

C member of Phosphoria formation

C-2	Chert and quartzite, calcareous	--	37.2	--	--	37.2	--	--	--	--
C-1	Dolomite, cherty	--	24.0	--	--	61.2	--	--	--	--

B member of Phosphoria formation

B-4	Chert and sandstone	DAB-186	1.0	2.9	82.3	1.0	2.90	.002	--	.002
B-3	Phosphate rock, cherty	RLP-185	1.0	27.9	21.9	2.0	30.80	.010	.008	.012
B-2	Chert, phosphatic and phosphate rock	RLP-184	0.8	22.4	31.9	2.8	48.72	.007	.006	.018
B-1	Quartzite and chert	RLP-183	3.7	2.4	85.7	6.5	57.60	.0005	--	.019

A member of Phosphoria formation

A-9	Mudstone	DAB-182	4.2	1.0	87.5	4.2	4.20	.002	--	.008
A-8	Mudstone, calcareous	DAB-181	10.6	0.6	73.4	14.8	10.56	.002	--	.030
A-7	Sandstone	DAB-180	3.1	0.3	79.5	17.9	11.49	.001	--	.033
A-6	Sandstone, calcareous	DAB-179	3.3	0.1	76.1	21.2	11.82	.002	--	.039
A-5	Mudstone, calcareous and sandstone	RLP-178	17.5	0.1	73.6	38.7	13.57	.002	--	.074
A-4	Mudstone	RLP-177	17.7	0.1	72.6	56.4	15.34	.002	--	.110

<sup>1</sup> Fossil collection made by K. P. McLaughlin, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				$P_2O_5$	Acid insoluble			eU	Chem. U	
A- 3	Mudstone, calcareous, sandy	RLP-176	23.7	0.3	75.6	80.1	22.45	.002	--	.157
A- 2	Sandstone, cherty?	DAB-175	6.3	0.3	94.9	86.4	24.34	.0005	--	.160
A- 1	Mudstone and sandstone	DAB-174	19.1	0.2	85.6	105.5	28.16	.0005	--	.170
Quadrant formation										
Cq-1	Sandstone, quartzitic	DAB-173	5.0	0.3	97.2	5.0	1.5	.000	--	.000

## CAVE CREEK, MONTANA. LOT NO. 1257.

D member of Phosphoria formation sampled in bulldozer trench on south side of Cave Creek, NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 10, T. 6 S., R. 10 W., Beaverhead County, Montana, about 2,000 feet west of axis of northeastward-plunging Cave Creek syncline. Beds strike N. 25° W. and dip 40° NE. Section measured by E. T. Ruppel and sampled by J. A. Kelleher in August 1948. Samples analyzed for  $P_2O_5$  and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
Dinwoody formation—not exposed													
E member of Phosphoria formation—top approximately located													
E- 8	Chert and quartzite	--	11.0	--	--	--	--	--	11.0	--	--	--	--
E- 7	Chert and quartzite	--	16.0	--	--	--	--	--	27.0	--	--	--	--
E- 6	Chert and quartzite	--	11.0	--	--	--	--	--	38.0	--	--	--	--
E- 5	Chert and quartzite	--	20.0	--	--	--	--	--	58.0	--	--	--	--
E- 4	Chert and quartzite	--	22.0	--	--	--	--	--	80.0	--	--	--	--
E- 3	Chert	--	28.0	--	--	--	--	--	108.0	--	--	--	--
E- 2	Chert	--	32.5	--	--	--	--	--	140.5	--	--	--	--
E- 1	Chert	ETR-620	3.5	3.1	--	--	--	88.8	144.0	--	.001	--	--
D member of Phosphoria formation—base not exposed													
--	Rhyolite?	ETR-619	(5.25)	0.9	--	--	--	92.4	--	--	.003	--	--
D-31	Phosphate rock	ETR-618	1.6	30.4	--	--	--	18.9	1.6	48.64	.006	.005	.010
D-30	Phosphate rock, argillaceous	ETR-617	1.8	29.4	1.6	1.24	2.26	21.5	3.4	101.56	.005	.005	.019
--	Flow breccia?	ETR-616	(1.2)	3.7	--	--	--	71.5	--	--	.003	--	--
D-29	Mudstone, phosphatic	ETR-615	1.4	9.7	1.8	1.00	2.18	58.7	4.8	115.14	.005	.005	.026
D-28	Mudstone	ETR-614	1.1	1.4	--	--	--	76.8	5.9	116.68	.004	--	.030
D-27	Mudstone	ETR-613	3.0	5.6	--	--	--	64.4	8.9	133.48	.005	.003	.045
D-26	Mudstone, phosphatic	ETR-612	1.9	8.5	--	--	--	62.2	10.8	149.63	.005	.003	.054
--	Rhyolite sill?	ETR-611	(2.3)	1.8	--	--	--	76.8	--	--	.012	.002	--
D-25	Mudstone	ETR-610	4.6	0.5	--	--	--	79.5	15.4	151.93	.003	--	.068
D-24	Phosphate rock	ETR-609	0.8	32.85	--	--	--	9.6	16.2	178.21	.007	.007	.074
D-23	Mudstone, phosphatic	ETR-608	0.5	15.85	--	--	--	43.5	16.7	186.14	.006	.003	.077
D-22	Phosphate rock, argillaceous	ETR-607	0.5	22.1	--	--	--	33.0	17.2	197.18	.006	.004	.080
D-21	Mudstone; fos. col. no. 48-KPM-56 <sup>1</sup>	ETR-606	0.8	6.7	--	--	--	66.3	18.0	202.54	.005	.002	.084
D-20	Phosphate rock, argillaceous	ETR-605	0.8	23.6	--	--	--	29.0	18.8	221.42	.007	.005	.090
D-19	Mudstone, phosphatic	ETR-604	1.1	14.4	--	--	--	49.8	19.9	237.26	.005	.004	.095
D-18	Phosphate rock, argillaceous	ETR-603	0.9	24.6	--	--	--	25.6	20.8	259.40	.007	.005	.101
D-17	Phosphate rock	ETR-602	0.75	30.7	--	--	--	15.0	21.55	282.43	.006	.004	.106

<sup>1</sup> Fossil collection made by K. P. McLaughlin, Paleontology and Stratigraphy Branch, U. S. Geological Survey.



Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
D-16	Phosphate rock and phosphatic mudstone	ETR-601	0.6	21.1	--	--	--	34.3	22.15	295.09	.005	.004	.109
D-15	Mudstone, phosphatic	ETR-600	0.7	11.8	--	--	--	57.0	22.85	303.35	.005	.003	.112
D-14	Mudstone, phosphatic	ETR-599	0.75	9.4	--	--	--	71.0	23.60	310.40	.003	--	.115
D-13	Mudstone, calcareous; fos. col. no. 48-KPM-55	ETR-598	0.6	2.0	--	--	--	59.5	24.20	311.60	.005	.003	.118
D-12	Phosphate rock, argillaceous	ETR-597	0.4	24.5	--	--	--	25.7	24.60	321.40	.007	.006	.120
D-11	Mudstone, phosphatic; fos. col. no. 48-KPM-54	ETR-596	0.8	10.5	--	--	--	57.8	25.40	329.80	.006	.004	.125
D-10	Phosphate rock, argillaceous	ETR-595	0.15	18.7	--	--	--	38.4	25.55	332.60	.008	.006	.126
D-9	Mudstone, phosphatic; fos. col. no. 48-KPM-53	ETR-594	0.4	14.7	--	--	--	45.1	25.95	338.48	.008	.005	.130
D-8	Mudstone, phosphatic	ETR-593	0.9	14.9	--	--	--	44.4	26.85	351.90	.006	.004	.135
D-7	Phosphate rock, argillaceous and mudstone; fos. col. no. 48-KPM-52	ETR-592	1.7	18.4	--	--	--	39.7	28.55	383.18	.007	.005	.147
D-6	Mudstone, phosphatic	ETR-591	0.55	13.8	--	--	--	51.3	29.10	390.76	.007	.005	.151
D-5	Mudstone	ETR-590	1.6	4.4	--	--	--	61.4	30.70	397.80	.004	--	.151
D-4	Mudstone, phosphatic, calcareous	ETR-589	1.3	13.6	--	--	--	44.6	32.00	415.48	.005	.003	.164
D-3	Mudstone	ETR-588	0.7?	6.4	--	--	--	62.3	32.70	419.96	.004	--	.167
D-2	Phosphate rock, argillaceous	ETR-587	0.3	29.4	--	--	--	21.6	33.00	428.78	.004	--	.168
D-1	Phosphate rock, sandy	ETR-586	--	20.2	--	--	--	45.4	--	--	.004	--	--

Stratigraphic interval of 116 feet between D-1 and approximate top of Quadrant formation includes few exposures of quartzite and limestone.

## JACK CANYON, MONTANA. LOT NO. 1218.

Phosphoria formation sampled in hand trench and outcrop about 900 feet above Jack Creek on north side of canyon in SE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 35, T. 5 S., R. 1 E., Madison County, Montana, on overturned and faulted west limb of Madison Range syncline. Beds strike N. 60° E. and dip 45° NW. Section measured by R. W. Swanson and sampled by J. G. Evans in September 1947. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
Dinwoody formation													
T-d-2	Mudstone, calcareous	--	6.0	--	--	--	--	--	6.0	--	--	--	--
T-d-1	Sandstone, calcareous, argillaceous	--	1.6	--	--	--	--	--	7.6	--	--	--	--
Phosphoria formation													
25	Chert and calcareous sandstone	RWS-107-47	8.2	0.8	1.6	2.6	12.2	68.4	8.2	6.56	.0005	--	.004
24	Sandstone, calcareous, and chert	RWS-106-47	18.1	1.5	0.5	1.3	9.7	74.0	26.3	33.71	.0005	--	.013
23	Sandstone, calcareous, and chert	RWS-105-47	12.8	1.5	0.5	1.9	6.5	81.3	39.1	52.91	.0005	--	.020
22	Chert, sandstone, and limestone	RWS-104-47	8.4	0.8	0.9	2.6	4.7	85.0	47.5	59.63	.0005	--	.024
21	Chert and quartzite	RWS-103-47	8.6	1.8	0.8	2.1	2.1	88.2	56.1	75.11	.0005	--	.028
20	Sandstone	RWS-102-47	10.5	1.4	0.6	1.1	9.0	75.3	66.6	89.81	.0005	--	.033
19	Quartzite	RWS-101-47	9.65	2.1	0.9	1.3	1.8	89.3	76.25	110.08	.0005	--	.038
18	Chert and quartzite	RWS-100-47	6.2	1.3	0.9	3.5	2.0	88.5	82.45	118.14	.0005	--	.041
17	Chert and mudstone	RWS-99-47	3.9	0.6	3.1	5.1	3.0	85.0	86.35	120.48	.0005	--	.043
16	Chert and mudstone	RWS-98-47	5.25	1.3	1.8	4.3	4.1	83.1	91.60	127.30	.0005	--	.046
15	Chert and mudstone	RWS-97-47	6.9	0.9	3.2	5.5	2.9	84.5	98.50	133.51	.001	--	.053
14	Phosphate rock, argillaceous	RWS-96-47	0.17	18.9	1.3	2.9	2.2	44.0	98.67	136.72	.004	--	.053
13	Chert and mudstone	RWS-95-47	2.4	1.2	6.0	5.2	4.2	81.3	101.07	139.60	.001	--	.056
12	Phosphate rock, argillaceous	RWS-94-47	0.5	22.9	1.4	2.6	1.8	37.4	101.57	151.05	.006	.005	.059
11	Chert and calcareous mudstone (may include 2.45 feet repetition by faulting)	RWS-93-47	3.25	0.8	3.6	4.1	11.9	67.8	104.82	153.65	.0005	--	.059
10	Chert and mudstone	RWS-92-47	4.05	0.6	4.7	4.7	2.4	87.3	108.87	156.08	.001	--	.063
9	Chert and mudstone	RWS-91-47	4.6	0.8	4.5	4.9	2.4	86.9	113.47	159.76	.0005	--	.066
8	Chert and mudstone	RWS-90-47	4.4	0.6	4.3	4.1	2.5	87.5	117.87	162.40	.001	--	.070
7	Phosphate rock	RWS-89-47	1.15	28.8	1.9	1.4	4.5	19.0	119.02	195.52	.010	.009	.081
6	Limestone, argillaceous	RWS-88-47	0.4	0.8	4.7	2.3	32.6	24.9	119.42	195.84	.001	--	.082
--	Feldspar porphyry	RWS-87-47	(3.0)	0.2	17.4	3.2	10.5	74.6	--	--	.001	--	--
--	Feldspar porphyry	RWS-86-47	(1.1)	0.5	16.9	3.1	11.1	73.3	--	--	.001	--	--
5	Sandstone, phosphatic, and phosphate rock	RWS-85-47	0.8	12.7	1.9	3.0	1.7	61.3	120.22	206.00	.004	.004	.085
4	Quartzite	RWS-84-47	4.6	1.3	0.5	1.8	2.4	90.7	124.82	211.98	.0005	--	.087
3	Quartzite, cherty	RWS-83-47	3.95	0.8	0.7	1.4	1.9	92.1	128.77	215.14	.0005	--	.089
2	Quartzite and chert	RWS-82-47	2.5	0.7	1.0	1.9	0.8	94.2	131.27	216.89	.0005	--	.091
1	Conglomerate, mudstone, and chert	RWS-81-47	0.6	2.4	2.8	3.1	7.3	73.8	131.87	218.33	.001	--	.091

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
Quadrant formation													
Cq-1	Mudstone, calcareous, sandy; and argillaceous, calcareous sandstone	RWS- 80-47	1.3	0.7	6.5	3.2	9.6	70.4	1.3	--	.001	--	--
Cq-2	Sandstone, quartzitic, cherty	--	2.2	--	--	--	--	--	3.5	--	--	--	--
Cq-3	Chert, sandstone, and limestone	--	11.5	--	--	--	--	--	15.0	--	--	--	--
Cq-4	Limestone, chert, and quartzite	--	11.0	--	--	--	--	--	26.0	--	--	--	--
Cq-5	Limestone, cherty	--	8.0	--	--	--	--	--	34.0	--	--	--	--

## SPECTROGRAPHIC ANALYSES—JACK CANYON, MONTANA. LOT NO. 1218.

Semi-quantitative analyses of samples of the Phosphoria formation, Jack Canyon, Montana (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Bureau of Mines Laboratory, Albany, Oregon. In addition to the elements listed in the table below, Sb, As, Ba, Be, Bi, Cd, Co, Cb, Ga, Ge, Au, In, Pb, Li, Hg, Pt, Ta, Sn, and W were looked for in all samples but were not detected.

## Explanation of symbols

A = more than 10 percent

B = 5-10 percent

C = 1-5 percent

D = 0.1-1 percent

E = 0.01-0.1 percent

F = 0.001-0.01 percent

G = less than 0.001 percent

ND = not detected

Bed no.	Sample no.	Al	B	Ca	Cr	Cu	Fe	Mg	Mn	Mo	Ni	Si	Ag	Na	Sr	Ti	V	Zn	Zr
25	RWS-107-47	C	F	B	ND	G	C	C	E	F	E	A	G	ND	F	E	F	E	E
24	RWS-106-47	C	F	A	ND	G	C	C	E	F	E	A	G	ND	F	E	F	E	E
23	RWS-105-47	C	F	B	ND	G	C	C	E	F	E	A	G	ND	F	E	F	E	E
22	RWS-104-47	C	F	C	ND	G	C	C	E	F	E	A	G	ND	F	E	F	E	E
21	RWS-103-47	C	F	C	ND	G	C	D	E	F	E	A	G	ND	F	E	F	E	E
20	RWS-102-47	D	F	B	E	G	C	C	E	F	E	A	G	E	F	E	E	E	E
19	RWS-101-47	D	F	B	E	G	C	C	E	F	E	A	G	E	F	E	E	E	E
18	RWS-100-47	D	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
17	RWS- 99-47	C	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
16	RWS- 98-47	C	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
15	RWS- 97-47	C	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
14	RWS- 96-47	C	F	A	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
13	RWS- 95-47	C	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
12	RWS- 94-47	C	F	A	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
11	RWS- 93-47	C	F	B	E	G	C	C	E	F	E	A	G	E	F	E	E	E	E
10	RWS- 92-47	C	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
9	RWS- 91-47	C	F	C	E	G	C	D	E	F	E	A	G	E	F	E	E	E	E
8	RWS- 90-47	C	F	C	E	G	C	D	E	F	F	A	G	E	F	E	E	ND	E
7	RWS- 89-47	C	F	A	E	G	C	D	F	F	F	A	G	E	F	E	E	ND	E
6	RWS- 88-47	C	F	A	E	G	C	C	F	F	F	A	G	E	F	E	E	ND	E
--	RWS- 87-47	C	F	C	ND	G	C	D	E	F	F	A	G	D	F	E	E	ND	E
--	RWS- 86-47	C	F	C	ND	G	C	D	E	F	F	A	G	D	F	E	E	ND	E
5	RWS- 85-47	C	F	A	ND	G	C	D	E	F	F	A	G	E	F	E	E	ND	E
4	RWS- 84-47	D	F	C	ND	G	C	D	E	F	F	A	G	E	F	E	E	ND	E
3	RWS- 83-47	D	F	C	ND	G	C	D	E	F	F	A	G	E	F	E	E	ND	E
2	RWS- 82-47	D	F	C	ND	G	C	D	F	F	F	A	G	E	F	E	E	ND	E
1	RWS- 81-47	C	F	B	ND	G	C	D	E	F	F	A	G	E	E	E	E	ND	E
Cq-1	RWS- 80-47	C	F	B	ND	G	C	C	E	F	F	A	G	E	E	E	E	E	E



ASPEN VALLEY, MONTANA. LOT NO. 1215.

Phosphatic shale member of Phosphoria formation sampled in hand trench near top of ridge on west side of Aspen Valley, SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 11, T. 6 S., R. 1 E., Madison County, Montana, on overturned west limb of Madison Range syncline. Beds strike N. 45° E. and dip 55° NW. Section measured by R. W. Swanson and sampled by J. A. Mann and J. G. Evans in August 1947. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)			Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	F	Acid insoluble			eU	Chem. U	
Phosphoria formation—top and base not exposed											
20	Sandstone	--	2.1	--	--	--	2.1	--	--	--	--
19	Quartzite	RWS-43-47	0.75	1.3	--	90.1	2.85	0.98*	.0005	--	.000*
18	Chert and mudstone	RWS-42-47	4.2	0.9	--	81.8	7.05	4.76	.0005	--	.002
17	Chert and mudstone	RWS-41-47	2.5	0.6	--	84.0	9.55	6.26	.0005	--	.004
16	Chert and mudstone	RWS-40-47	4.45	0.7	--	78.0	14.00	9.37	.0005	--	.006
15	Mudstone	RWS-39-47	0.55	1.3	--	75.4	14.55	10.08	.001	--	.006
14	Phosphate rock, cherty	RWS-38-47	0.25	23.5	2.05	31.4	14.80	15.96	.007	.006	.008
13	Limestone, argillaceous	RWS-37-47	1.0	0.5	--	37.6	15.80	16.46	.0005	--	.009
12	Chert and mudstone	RWS-36-47	4.55	0.5	--	50.6	20.35	18.74	.001	.000	.013
11	Chert and mudstone	RWS-35-47	4.45	0.7	--	82.1	24.80	21.85	.0005	--	.016
10	Chert and mudstone	RWS-34-47	4.5	0.7	--	82.4	29.30	25.00	.0005	--	.018
9	Chert and mudstone	RWS-33-47	2.25	0.5	--	84.9	31.55	26.12	.0005	--	.019
8	Phosphate rock	RWS-32-47	1.6	31.0	3.0	11.8	33.15	75.82	.009	.008	.033
7	Phosphate rock	RWS-31-47	0.3	26.9	2.97	18.0	33.45	83.80	.015	.014	.038
6	Mudstone	RWS-30-47	0.45	1.4	--	72.3	33.90	84.42	.003	--	.039
5	Limestone	RWS-29-47	0.83	0.7	--	15.4	34.73	85.01	.0005	--	.040
4	Mudstone, calcareous	RWS-28-47	0.7	3.7	--	56.7	35.43	87.60	.005	.003	.043
3	Phosphate rock and mudstone	RWS-27-47	0.6	14.6	1.52	37.0	36.03	96.36	.010	.004	.049
2	Phosphate rock and phosphatic sandstone	RWS-26-47	0.55	21.3	---	38.9	36.58	108.07	.007	.006	.053
1	Sandstone	RWS-25-47	0.8	1.6	--	92.9	37.38	109.35**	.0005	--	.053**

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.

## SHELL CANYON, MONTANA. LOT NO. 1214.

Phosphoria formation measured and phosphatic shale member sampled in hand trench and outcrop on north side of Shell Creek canyon, SW 1/4 NE 1/4 sec. 33, T. 6 S., R. 1 E., Madison County, Montana, near crest of small dome at west side of Madison Range syncline. Beds strike N. 5° W. and dip 12° W. Section measured by R. W. Swanson and sampled by J. A. Mann and J. G. Evans in August 1947. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)			Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	F	Acid insoluble			eU	Chem. U	
Dinwoody formation											
Td-1	Limestone	--	25.0	--	--	--	25.0	--	--	--	--
Phosphoria formation											
43	Sandstone, calcareous, cherty	--	0.75	--	--	--	0.75	--	--	--	--
42	Sandstone, calcareous, cherty	--	6.0	--	--	--	6.75	--	--	--	--
41	Chert and sandstone	--	3.4	--	--	--	10.15	--	--	--	--
40	Quartzite	--	2.8	--	--	--	12.95	--	--	--	--
39	Limestone, cherty	--	1.45	--	--	--	14.40	--	--	--	--
38	Chert and quartzite	--	4.3	--	--	--	18.70	--	--	--	--
37	Quartzite and chert	--	7.4	--	--	--	26.10	--	--	--	--
36	Chert and quartzite	--	5.8	--	--	--	31.90	--	--	--	--
35	Quartzite	--	2.9	--	--	--	34.80	--	--	--	--
34	Quartzite and chert	--	11.3	--	--	--	46.10	--	--	--	--
33	Quartzite	--	5.2	--	--	--	51.30	--	--	--	--
32	Sandstone and chert	--	3.3	--	--	--	54.60	--	--	--	--
31	Chert, contains sandstone lenses	--	3.0	--	--	--	57.60	--	--	--	--
30	Sandstone, quartzitic	--	5.3	--	--	--	62.90	--	--	--	--
29	Sandstone, quartzitic, cherty	--	1.7	--	--	--	64.60	--	--	--	--
28	Chert and quartzitic sandstone	--	4.6	--	--	--	69.20	--	--	--	--
27	Chert and quartzite	RWS-24-47	0.7	1.6	--	90.2	69.90	1.12*	.0005	--	.000*
26	Chert	RWS-23-47	3.2	0.6	--	86.7	73.10	3.04	.0005	--	.002
25	Chert, contains thin mudstone partings	RWS-22-47	4.15	0.8	--	84.7	77.25	6.36	.0005	.000	.004
24	Chert, contains thin mudstone partings	RWS-21-47	5.0	0.5	--	85.0	82.25	8.86	.0005	--	.007
23	Chert, contains thin mudstone partings	RWS-20-47	5.2	0.6	--	82.1	87.45	11.98	.0005	.000	.009
22	Chert, contains thin mudstone partings	RWS-19-47	5.1	0.9	--	82.3	92.55	16.57	.0005	.000	.012
21	Mudstone, calcareous	RWS-18-47	1.2	1.1	--	73.7	93.75	17.89	.001	.000	.013
20	Phosphate rock, cherty	RWS-17-47	0.55	19.2	--	43.9	94.30	28.45	.006	.003	.016
19	Mudstone, calcareous	RWS-16-47	1.15	0.8	--	50.0	95.45	29.37	.001	--	.017
18	Mudstone, calcareous	RWS-15-47	3.7	0.9	--	74.9	99.15	32.70	.001	--	.021
17	Mudstone, cherty, calcareous	RWS-14-47	0.75	0.6	--	72.0	99.90	33.15	.0005	.000	.021

\* Cumulative data incomplete due to missing information.

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Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)			Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	F	Acid insoluble			eU	Chem. U	
16	Mudstone	RWS-13-47	2.05	0.1	--	80.5	101.95	33.36	.001	.000	.023
15	Phosphate rock, argillaceous	RWS-12-47	0.75	23.6	2.48	30.2	102.70	51.06	.008	.006	.029
14	Phosphate rock	RWS-11-47	0.5	32.4	3.43	8.1	103.20	67.26	.011	.013	.035
13	Phosphate rock	RWS-10-47	1.5	32.5	3.44	8.4	104.70	116.01	.011	.009	.051
12	Mudstone	RWS- 9-47	0.5	3.7	--	70.6	105.20	117.86	.004	.001	.053
11	Limestone, argillaceous	RWS- 8-47	1.2	0.5	--	20.0	106.40	118.46	.0005	--	.054
10	Mudstone, calcareous	RWS- 7-47	0.8	3.6	--	55.2	107.20	121.34	.003	--	.056
9	Mudstone, calcareous	RWS- 6-47	0.45	6.0	0.79	47.3	107.65	124.04	.005	.003	.059
8	Mudstone and phosphate rock	RWS- 5-47	0.65	14.9	1.58	40.4	108.30	133.72	.009	.004	.065
7	Sandstone, quartzitic, phosphatic and chert	RWS- 4-47	1.0	9.5	--	70.5	109.30	143.22	.003	.002	.068
6	Sandstone, quartzitic	RWS- 3-47	1.9	1.1	--	90.1	111.20	145.31	.0005	.002	.068
5	Sandstone, quartzitic	RWS- 2-47	0.85	1.0	--	93.3	112.05	146.16	.0005	.000	.069
4	Sandstone, quartzitic	RWS- 1-47	0.7	0.8	--	92.2	112.75	146.79**	.0005	.000	.069**
3	Sandstone, quartzitic	--	5.55	--	--	--	118.30	--	--	--	--
2	Chert	--	3.75	--	--	--	122.05	--	--	--	--
1	Sandstone, quartzitic and chert	--	2.5	--	--	--	124.55	--	--	--	--
Quadrant formation											
Cq-1	Limestone, cherty	--	3.0	--	--	--	3.0	--	--	--	--
Cq-2	Sandstone, quartzitic	--	10.	--	--	--	13.0	--	--	--	--

\*\* Note incompleteness of cumulative data.

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## WEST FORK OF GALLATIN RIVER, MONTANA. LOT NO. 1216.

Part of Phosphoria formation sampled in hand trench and outcrops on slope north of West Fork of Gallatin River, NW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 32, T. 6 S., R. 4 E., Gallatin County, Montana, from strata dragged up beneath Gardiner thrust fault. Beds strike N. 35° W. and dip 45-50° SW. Section measured by R. W. Swanson and sampled by J. A. Mann and J. G. Evans in September 1947. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Phosphoria formation—lower part only										
25	Sandstone, quartzitic and chert	--	10.5	--	--	10.5	--	--	--	--
24	Quartzite, contains chert concretions	--	2.0	--	--	12.5	--	--	--	--
23	Limestone, contains chert concretions	--	0.7	--	--	13.2	--	--	--	--
22	Chert and quartzite	--	5.5	--	--	18.7	--	--	--	--
21	Chert, quartzite and mudstone	RWS-63-47	8.85	0.8	90.1	27.55	7.08*	.0005	--	.004*
20	Quartzite	RWS-62-47	0.65	2.0	89.2	28.20	8.38	.0005	--	.005
19	Chert and mudstone	RWS-61-47	5.75	0.7	84.8	33.95	12.41	.0005	--	.008
18	Chert and mudstone	RWS-60-47	3.4	0.6	90.7	37.35	14.45	.0005	--	.009
17	Chert and mudstone	RWS-59-47	4.45	0.7	91.0	41.80	17.56	.0005	--	.012
16	Mudstone, phosphatic	RWS-58-47	0.3	14.9	56.3	42.10	22.03	.006	.005	.013
15	Mudstone	RWS-57-47	1.35	0.9	81.1	43.45	23.25	.001	--	.015
14	Mudstone	RWS-56-47	1.8	0.8	88.1	45.25	24.69	.001	--	.017
13	Mudstone	RWS-55-47	0.85	0.8	81.1	46.10	25.37	.002	--	.018
12	Mudstone	RWS-54-47	2.5	1.1	84.2	48.60	28.12	.001	.000	.021
11	Phosphate rock, argillaceous	RWS-53-47	0.45	22.2	39.4	49.05	38.11	.008	.008	.024
10	Phosphate rock, argillaceous	RWS-52-47	0.7	26.2	77.0	49.75	56.45	.009	.007	.031
9	Sandstone, phosphatic	RWS-51-47	1.5	8.3	70.2	51.25	68.90	.003	.001	.035
8	Sandstone	RWS-50-47	1.6	0.6	88.1	52.85	69.86	.0005	.000	.036
7	Mudstone, contains quartzitic sandstone concretions	RWS-49-47	1.3	1.1	81.3	54.15	71.29	.001	.000	.037
6	Chert, calcareous mudstone, and quartzite	RWS-48-47	1.35	1.5	55.0	55.50	73.31	.0005	.000	.038
5	Quartzite, cherty	RWS-47-47	2.2	1.4	91.9	57.70	76.39	.001	.000	.040
4	Mudstone, sandy, contains quartzitic concretions	RWS-46-47	1.15	2.2	87.2	58.85	78.92	.005	.000	.046
3	Mudstone, calcareous and quartzite	RWS-45-47	1.05	0.9	77.1	59.90	79.87	.0005	--	.046
2	Sandstone, quartzitic	RWS-44-47	1.2	0.8	95.2	61.10	80.83**	.0005	.000	.047**
1	Quartzite	--	4.3	--	--	65.40	--	--	--	--
Quadrant formation										
Cq-1	Chert	--	1.8	--	--	1.8	--	--	--	--
Cq-2	Chert and sandstone	--	6.3	--	--	8.1	--	--	--	--

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.

PORCUPINE CREEK, MONTANA. LOT NO. 1217.

Part of Phosphoria formation sampled in hand trench and outcrops on slope  $1\frac{1}{2}$  miles north of Porcupine Creek, NE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 10, T. 7 S., R. 4 E., Gallatin County, Montana, from strata dragged up beneath Gardiner thrust fault. Beds strike N. 40° W. and dip 75° SW. Section measured by R. W. Swanson and sampled by J. A. Mann and J. G. Evans in September 1947. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Phosphoria formation—lower part only										
20	Sandstone	--	5.0	--	--	6.0	--	--	--	--
19	Chert, contains sandstone lenses	--	2.6	--	--	8.6	--	--	--	--
18	Sandstone	--	4.8	--	--	13.4	--	--	--	--
17	Sandstone, quartzitic	RWS-79-47	0.6	1.6	93.1	14.0	0.96*	.0005	--	.000*
16	Chert, contains mudstone partings	RWS-78-47	4.6	0.8	82.1	18.6	4.64	.0005	--	.003
15	Chert, contains mudstone partings	RWS-77-47	3.9	0.4	86.0	22.5	6.20	.0005	--	.005
14	Chert, contains mudstone partings	RWS-76-47	3.6	0.9	84.8	26.1	9.44	.0005	--	.006
13	Chert, contains mudstone partings	RWS-75-47	1.55	3.3	87.0	27.65	14.56	.0005	--	.007
12	Chert, contains mudstone partings	RWS-74-47	1.0	0.8	87.4	28.65	15.36	.0005	--	.008
11	Chert, contains mudstone partings	RWS-73-47	0.95	0.6	86.0	29.60	15.93	.0005	--	.008
10	Chert, contains mudstone partings	RWS-72-47	1.65	1.1	87.4	31.25	17.75	.0005	--	.009
9	Sandstone	RWS-71-47	0.6	6.9	76.6	31.85	21.89	.001	--	.010
8	Mudstone, calcareous	RWS-70-47	0.8	1.4	60.8	32.65	23.01	.001	--	.010
7	Limestone, argillaceous	RWS-69-47	0.7	0.4	45.5	33.35	23.29	.0005	--	.011
6	Mudstone	RWS-68-47	2.9	1.6	81.8	36.25	27.93	.002	--	.016
5	Phosphate rock and mudstone	RWS-67-47	1.0	22.9	35.0	37.25	50.83	.009	.007	.025
4	Limestone, contains sandstone concretions	RWS-66-47	1.25	0.8	59.3	38.50	51.83	.0005	--	.026
3	Mudstone, contains sandstone concretions	RWS-65-47	0.6	1.8	78.5	39.10	52.91	.0005	--	.026
2	Sandstone, quartzitic	RWS-64-47	0.67	2.6	86.7	39.77	54.65**	.0005	--	.027**
1	Sandstone	--	9.5	--	--	49.27	--	--	--	--
Quadrant formation										
Cq-1	Sandstone	--	1.5	--	--	1.5	--	--	--	--
Cq-2	Sandstone and chert	--	11.4	--	--	12.9	--	--	--	--
Cq-3	Sandstone	--	10.0	--	--	22.9	--	--	--	--

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.

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## DALY'S SPUR, MONTANA. LOT NOS. 1222 AND 1223.

Phosphoria formation sampled near Daly's Spur, west side of Beaverhead River; A, B, C, and E members, lot no. 1223, sampled in hand trench and natural exposures, SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 36; and D member, lot no. 1222, in hand trench, NW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 36, T. 8 S., R. 10 W., Beaverhead County, Montana. Beds strike north to N. 30° E. and dip 30-40° W. Section measured by W. R. Lowell and sampled by D. A. Bostwick, R. L. Parker, and E. T. Ruppel in July 1937. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)			Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	F	Acid insoluble			eU	Chem. U	
Dinwoody formation—base not exposed											
E member of Phosphoria formation, lot no. 1223—top not exposed											
	Dinwoody-Phosphoria contact concealed by basalt flow, estimated thickness of covered E member	--	20.0	--	--	--	20.0	--	--	--	--
E- 10	Quartzite	WRL-286-47	23.7	2.2	--	89.4	43.7	52.14*	.001	.000	.024*
E- 9	Chert	WRL-285-47	12.5	1.5	--	91.0	56.2	70.89	.001	.000	.036
E- 8	Quartzite, chert, and sandstone	WRL-284-47	9.8	2.2	--	89.5	66.0	92.45	.001	.000	.046
E- 7	Chert, sandy	WRL-283-47	20.4	1.5	--	90.1	86.4	123.05	.001	.000	.066
E- 6	Chert, sandy	WRL-282-47	22.3	1.6	--	89.6	108.7	158.73	.0005	.000	.078
E- 5	Chert	WRL-281-47	7.4	2.5	--	87.3	116.1	177.23	.001	.000	.085
E- 4	Chert, sandy	WRL-280-47	14.7	1.7	--	89.1	130.8	202.22	.0005	.000	.092
E- 3	Mudstone, contains gypsum	WRL-279-47	0.5	2.2	--	78.3	131.3	203.32	.001	.000	.093
E- 2	Chert	WRL-278-47	3.6	2.6	--	86.3	134.9	282.68	.001	.000	.096
E- 1	Quartzite, cherty, phosphatic	WRL-277-47	1.2	16.6	--	50.6	136.1	232.60**	.008	.005	.106**
--	Chert	WRL-46-47	--	5.9	--	78.5	--	--	.003	.001	--
WRL-46-47 is correlative with WRL-277-47 but occurs in same trench as D member.											
D member of Phosphoria formation, lot no. 1222											
D-45	Mudstone	WRL-45-47	1.0	3.5	--	80.0	1.0	3.50	.003	.000	.003
D-44	Mudstone	WRL-44-47	1.3	3.2	--	78.5	2.3	7.66	.002	.000	.006
D-43	Mudstone	WRL-43-47	1.4	1.8	--	66.7	3.7	10.18	.002	.001	.008
D-42	Phosphate rock, argillaceous	WRL-42-47	0.8	25.3	2.44	30.1	4.5	30.42	.007	.009	.014
D-41	Mudstone, phosphatic	WRL-41-47	0.7	13.7	1.17	51.1	5.2	40.01	.004	.002	.017
D-40	Phosphate rock, argillaceous	WRL-40-47	0.3	28.6	--	22.2	5.5	48.59	.008	.007	.019
D-39	Mudstone, phosphatic	WRL-39-47	1.2	17.0	1.60	45.1	6.7	68.99	.016	.005	.038
D-38	Phosphate rock and phosphatic mudstone	WRL-38-47	1.5	22.1	--	32.8	8.2	102.14	.007	.007	.049
D-37	Mudstone, calcareous	WRL-37-47	0.9	6.1	--	45.5	9.1	107.63	.004	--	.052
D-36	Phosphate rock, argillaceous	WRL-36-47	0.5	22.2	--	32.0	9.7	120.95	.010	.010	.058

\* Cumulative data incomplete due to missing information.

\*\* Note incompleteness of cumulative data.

RESTRICTED



Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)			Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	F	Acid insoluble			eU	Chem. U	
D-35	Mudstone, phosphatic	WRL- 35-47	0.5	10.1	--	53.8	10.2	126.00	.006	.004	.062
D-34	Mudstone	WRL- 34-47	0.4	4.8	0.41	71.5	10.6	127.92	.004	--	.063
D-33	Phosphate rock, argillaceous	WRL- 33-47	0.4	22.4	--	23.5	11.0	136.88	.010	.008	.067
D-32	Mudstone, calcareous	WRL- 32-47	0.3	2.9	--	55.8	11.3	137.75	.003	--	.068
D-31	Phosphate rock, argillaceous	WRL- 31-47	0.3	19.0	--	33.0	11.6	143.45	.009	.007	.071
D-30	Mudstone, calcareous	WRL- 30-47	4.0	4.2	--	42.6	15.6	160.25	.003	--	.083
D-29	Mudstone, calcareous	WRL- 29-47	5.0	2.9	--	49.9	20.6	174.75	.004	--	.103
D-28	Mudstone, calcareous	WRL- 28-47	0.8	2.7	--	61.3	21.4	176.91	.003	--	.105
D-27	Mudstone, calcareous	WRL- 27-47	2.1	0.6	--	65.9	23.5	178.17	.002	--	.109
D-26	Mudstone, calcareous	WRL- 26-47	1.6	1.6	--	67.9	25.1	180.73	.003	--	.114
D-25	Mudstone, calcareous	WRL- 25-47	2.7	2.0	--	63.3	27.8	186.13	.003	--	.122
D-24	Mudstone, calcareous	WRL- 24-47	1.2	1.6	--	65.5	29.0	188.05	.002	--	.125
D-23	Mudstone, calcareous	WRL- 23-47	1.2	0.6	--	63.6	30.2	188.77	.002	--	.127
D-22	Mudstone, calcareous	WRL- 22-47	1.6	1.1	--	35.0	31.8	190.53	.002	--	.130
D-21	Mudstone, calcareous	WRL- 21-47	0.8	1.2	--	69.4	32.6	191.49	.002	--	.132
D-20	Mudstone	WRL- 20-47	1.7	1.8	--	71.5	34.3	194.55	.002	--	.135
D-19	Mudstone, calcareous	WRL- 19-47	1.2	2.9	--	50.2	35.5	198.03	.004	.002	.140
D-18	Phosphate rock	WRL- 18-47	0.3	27.4	3.8	19.3	35.8	206.25	.007	.005	.142
D-17	Mudstone, calcareous	WRL- 17-47	0.8	4.4	--	60.6	36.6	209.77	.003	.002	.144
D-16	Phosphate rock	WRL- 16-47	1.2	33.1	4.1	6.7	37.8	249.79	.007	.007	.153
D-15	Mudstone, calcareous	WRL- 15-47	1.4	6.8	--	52.3	39.2	259.01	.005	.003	.160
D-14	Phosphate rock, argillaceous	WRL- 14-47	1.7	22.6	--	24.62	40.9	297.43	.007	.005	.172
D-13	Limestone	WRL- 13-47	0.9	3.9	--	18.6	41.8	300.94	.001	--	.173
D-12	Mudstone, phosphatic	WRL- 12-47	0.8	10.0	--	49.1	42.6	308.94	.004	--	.176
D-11	Phosphate rock and mudstone	WRL- 11-47	0.5	22.8	--	21.3	43.1	320.34	.005	.003	.178
D-10	Mudstone and phosphate rock	WRL- 10-47	1.3	11.0	--	48.3	44.4	334.64	.004	--	.184
D- 9	Phosphate rock, argillaceous	WRL- 9-47	1.3	24.4	2.48	24.7	45.7	366.36	.005	.005	.190
D- 8	Mudstone, calcareous	WRL- 8-47	0.5	0.2	--	68.3	46.2	366.46	.001	--	.191
D- 7	Mudstone and phosphate rock	WRL- 7-47	1.5	14.7	1.28	48.2	47.7	388.51	.005	.003	.198
D- 6	Mudstone	WRL- 6-47	1.0	5.3	0.68	71.2	48.7	393.81	.002	.003	.200
D- 5	Phosphate rock, argillaceous	WRL- 5-47	1.6	17.2	--	35.9	50.3	421.33	.005	.003	.208
D- 4	Phosphate rock, argillaceous, contains gypsum	WRL- 4-47	1.4	20.3	--	27.5	51.7	449.75	.005	.003	.215
D- 3	Mudstone, phosphatic, contains gypsum	WRL- 3-47	0.9	8.8	--	62.1	52.6	457.67	.004	.002	.219
D- 2	Mudstone	WRL- 2-47	0.8	3.3	--	75.8	53.4	460.31	.003	.007	.221
D- 1	Mudstone, phosphatic	WRL- 1-47	1.2	13.8	1.33	45.9	54.6	476.87	.005	.003	.227
C member of Phosphoria formation, lot no. 1223											
C-11	Sandstone	WRL-276-47	2.2	15.1	1.39	56.1	2.2	33.22	.003	.003	--*
C-10	Sandstone and chert	WRL-275-47	2.7	3.9	--	77.2	4.9	43.75	.001	.001	--

\* Cumulative data incomplete due to missing information.

C- 9	Sandstone, calcareous	WRL-274-47	8.7	0.8	--	46.9	13.6	80.71	.001	.000	--
C- 8	Sandstone	WRL-273-47	11.0	1.3	--	90.8	24.6	65.01	--	--	--
C- 7	Chert and sandstone	WRL-272-47	9.0	0.2	--	95.1	33.6	66.81	.0005	.000	--
C- 6	Sandstone and cherty mudstone	WRL-271-47	14.5	0.5	--	92.8	48.1	74.06	--	--	--
C- 5	Sandstone and chert	WRL-270-47	2.8	1.3	--	91.3	50.9	77.70	--	--	--
C- 4	Sandstone	WRL-269-47	7.4	2.5	--	78.2	58.3	96.20	.001	.000	--
C- 3	Sandstone, cherty	WRL-268-47	9.2	5.4	0.71	80.0	67.5	145.88	.001	.000	--
C- 2	Sandstone and chert	WRL-267-47	11.0	1.9	--	87.6	78.5	166.78	.001	.000	--
C- 1	Sandstone and chert	WRL-266-47	12.1	1.1	--	92.5	90.6	180.09	.001	.000	--
B member of Phosphoria formation, lot no. 1223											
B- 5	Mudstone	WRL-265-47	3.1	6.7	0.68	67.0	3.1	20.77	.005	.003	.016
B- 4	Mudstone	WRL-264-47	0.8	6.0	--	69.6	3.9	25.57	.003	.001	.018
B- 3	Phosphate rock	WRL-263-47	0.4	35.7	3.56	6.4	4.3	39.85	.011	.010	.028
B- 2	Mudstone	WRL-262-47	0.3	4.5	--	76.5	4.6	41.20	.003	.001	.028
B- 1	Phosphate rock	WRL-261-47	0.7	36.4	3.57	5.2	5.3	66.68	.009	.008	.030
A member of Phosphoria formation, lot no. 1223											
A-10	Sandstone	WRL-260-47	2.4	4.4	--	84.4	2.4	10.56	.001	.001	.002
A- 9	Sandstone and mudstone	WRL-259-47	3.3	0.5	--	82.0	5.7	12.21	.002	.000	.009
A- 8	Sandstone, cherty	WRL-258-47	1.4	0.8	--	90.5	7.1	13.33	.001	.000	.010
A- 7	Mudstone	WRL-257-47	4.2	0.6	--	80.0	11.3	15.85	.002	.000	.019
A- 6	Sandstone, calcareous	WRL-256-47	3.0	0.1	--	76.6	14.3	16.15	.001	.000	.022
A- 5	Limestone	WRL-255-47	2.8	0.2	--	18.9	17.1	16.71	.0005	.000	.023
A- 4	Mudstone	WRL-254-47	0.7	0.5	--	79.3	17.8	17.06	.002	.000	.025
A- 3	Limestone	WRL-253-47	3.5	0.0	--	2.6	21.3	17.06	.0005	.000	.026
A- 2	Mudstone	WRL-252-47	1.5	0.4	--	80.6	22.8	17.66	.002	.000	.029
A- 1	Limestone	WRL-251-47	6.7	0.3	--	1.9	29.5	19.67	.0005	.000	.033
Quadrant formation											
--	Thickness of Quadrant formation exposed in cliff	--	400.	--	--	--	--	--	--	--	--

## SHEEP CREEK, MONTANA. LOT NO. 1234.

Phosphoria formation sampled in two bulldozer trenches near Sheep Creek Canyon, NW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 23, T. 9 S., R. 9 W., Beaverhead County, Montana, on west side of Small Horn Canyon anticline. Beds strike N. 23-41° E. and dip 30-45° NW. Section measured by L. A. Thomas, E. R. Cressman, O. A. Payne, V. E. McKelvey, D. A. Bostwick, F. S. Honkala, and J. E. Smedley and sampled by W. H. Wilson, Payne, R. L. Konizeski, Thomas, and Cressman in June 1948. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			eU	Chem. U	
Dinwoody formation—basal bed only													
D-1	Mudstone, calcareous	DAB- 80	--	1.0	8.1	4.0	10.0	71.4	--	--	.0005	.001	--
E member of Phosphoria formation													
E-11	Sandstone, fos. col. no. 48-KPM-43 <sup>1</sup>	DAB- 79	1.9	1.7	2.5	4.6	1.5	87.9	1.9	3.23	.0005	.000	.000
E-10	Mudstone and chert	LAT- 78	10.2	1.6	5.1	3.0	2.3	87.3	12.1	19.55	.0005	.000	.000
E- 9	Chert and mudstone	LAT- 77	13.7	2.1	4.4	3.4	1.8	88.9	25.8	48.32	.0005	.001	.014
E- 8	Sandstone, chert, and mudstone; fos. col. no. 48-KPM-42	LAT- 76	13.5	1.7	2.3	3.5	1.5	88.6	39.3	71.27	.0005	.001	.027
E- 7	Sandstone and chert	ERC- 75	14.0	2.4	2.1	3.9	1.0	86.9	53.3	104.87	.0005	.001	.041
E- 6	Sandstone and chert	ERC- 74	17.1	2.6	2.9	2.8	1.3	88.1	70.4	149.33	.0005	.000	.041
E- 5	Sandstone	ERC- 73	13.6	2.7	1.0	4.0	1.0	87.0	84.0	186.05	.0005	.001	.055
E- 4	Mudstone and chert	DAB- 72	10.5	3.3	2.2	3.2	1.2	86.5	94.5	220.70	.0005	.001	.065
E- 3	Mudstone	DAB- 71	10.8	1.6	4.8	2.3	2.8	88.3	105.3	237.98	.0005	.001	.076
E- 2	Sandstone and chert	DAB- 70	4.1	3.0	1.0	3.2	0.8	87.9	109.4	250.28	.0005	.001	.080
E- 1	Sandstone, phosphatic, fos. col. no. 48-KPM-41	DAB- 69	0.75	17.2	2.2	1.5	2.8	51.1	110.15	263.18	.006	.003	.082
D member of Phosphoria formation													
D-48	Mudstone, phosphatic	VEM- 1	0.9	16.2	7.4	3.6	8.0	43.6	0.9	14.58	.007	.004	.004
D-47	Mudstone, fos. col. no. 48-KPM-40	VEM- 2	1.3	7.4	9.2	2.4	9.7	64.6	2.2	34.20	.004	.001	.005
D-46	Mudstone, phosphatic, fos. col. no. 48-KPM-39	VEM- 3	2.3	12.5	8.7	2.3	10.0	51.9	4.5	52.95	.004	.004	.014
D-45	Mudstone, fos. col. no. 48-KPM-38	VEM- 4	1.3	1.7	11.2	1.9	9.3	79.0	5.8	55.16	.003	.001	.015
D-44	Mudstone	JES- 5	2.2	3.2	9.9	4.3	13.4	70.4	8.0	62.20	.002	.002	.020
D-43	Mudstone	JES- 6	0.5	1.6	8.8	2.0	11.8	76.3	8.5	63.00	.002	.002	.021
D-42	Mudstone, phosphatic	JES- 7	1.6	15.6	6.7	2.8	11.1	45.9	10.1	87.96	.008	.007	.032
D-41	Mudstone, phosphatic	JES- 8	1.4	9.2	9.0	3.3	14.2	54.4	11.5	100.84	.005	.005	.039
D-40	Phosphate rock, argillaceous	OAP- 9	0.5	22.1	4.7	2.3	7.5	34.5	12.0	111.89	.005	.001	.040
--	Mudstone and phosphate rock	OAP-335	(0.3)	23.8	4.1	1.8	6.9	28.7	--	--	.0005	.002	--
OAP-385 represents the same bed as OAP-9 but was collected from a more weathered zone.													
D-39	Mudstone	OAP- 10	0.4	3.8	12.2	3.1	16.8	67.0	12.4	113.41	.003	.001	.040
D-38	Phosphate rock, argillaceous	OAP- 11	0.3	18.3	7.0	2.4	14.0	34.4	12.7	118.90	.007	.002	.040

D-37	Mudstone	OAP- 12	0.3	6.7	10.3	3.6	12.8	60.7	13.0	120.91	.004	.001	.041
D-36	Phosphate rock, argillaceous	OAP- 13	1.9	17.6	6.5	2.1	13.2	36.3	14.9	154.35	.007	.005	.050
D-35	Phosphate rock, argillaceous	LAT- 14	0.5	25.8	2.9	1.9	6.8	28.1	15.4	167.25	.006	.002	.051
--	Phosphate rock, argillaceous	LAT-386	(0.5)	25.4	2.8	1.0	9.3	27.1	--	--	.006	.005	--
LAT-386 represents the same bed as LAT-14 but was sampled where the unit appeared to contain more argillaceous material.													
D-34	Phosphate rock, argillaceous	FSH- 15	0.8	20.2	4.8	1.6	9.0	37.7	16.2	183.41	.006	.002	.053
D-33	Mudstone and phosphate rock	FSH- 16	0.85	20.2	5.8	2.1	10.5	35.6	17.05	200.58	.008	.004	.056
D-32	Mudstone	FSH- 17	0.8	6.4	9.6	2.5	14.1	60.9	17.85	205.70	.005	.003	.059
D-31	Phosphate rock, argillaceous	FSH- 18	0.8	26.0	3.9	1.5	8.9	25.5	18.65	226.50	.008	.004	.062
D-30	Mudstone	FSH- 19	2.7	5.2	10.2	3.2	18.4	60.5	21.35	240.54	.005	.002	.067
D-29	Mudstone	ERC- 20	1.0	1.4	10.7	2.9	20.8	72.7	22.35	241.94	.002	.001	.068
D-28	Mudstone	LAT- 21	2.2	3.5	10.0	3.4	16.4	64.2	24.55	249.64	.002	.003	.075
D-27	Mudstone, calcareous; fos. col. no. 48-KPM-37	LAT- 22	1.5	2.4	9.2	3.7	30.1	53.3	26.05	253.24	.003	.002	.078
D-26	Mudstone	LAT- 23	0.9	1.6	9.8	4.1	30.5	54.2	26.95	254.58	.002	.001	.079
D-25	Mudstone, calcareous	LAT- 24	2.8	1.4	10.9	3.7	21.1	63.2	29.75	258.60	.0005	.001	.082
D-24	Mudstone, calcareous	ERC- 25	0.9	4.5	11.1	4.7	20.9	64.3	30.65	262.65	.004	.002	.083
--	Mudstone	ERC-387	(0.85)	2.7	1.1	3.5	22.1	63.4	--	--	.003	.001	--
ERC-387 represents the same bed as ERC-25 but was sampled where the unit appeared to contain more argillaceous material.													
D-23	Mudstone, calcareous	ERC- 26	1.9	1.6	10.6	4.1	30.6	56.7	32.55	265.69	.003	.001	.085
D-22	Mudstone, calcareous	ERC- 27	0.8	2.2	9.0	2.8	26.2	63.6	33.35	267.45	.003	.003	.088
D-21	Mudstone, calcareous	ERC- 28	0.75	3.8	10.0	1.9	30.0	58.0	34.10	270.30	.002	.003	.090
D-20	Phosphate rock, argillaceous; fos. col. no. 48-KPM-36	LAT- 29	1.05	26.2	5.6	2.9	14.3	24.0	35.15	297.81	.004	.003	.093
D-19	Phosphate rock	LAT- 30	0.65	31.9	3.9	1.9	8.1	13.8	35.80	318.54	.007	.006	.097
D-18	Phosphate rock, argillaceous	LAT- 31	1.55	24.0	5.6	1.5	16.8	21.2	37.35	355.74	.007	.004	.103
D-17	Phosphate rock and mudstone	DAB- 32	0.85	21.3	6.8	1.7	20.0	23.7	38.20	373.85	.006	.004	.107
D-16	Phosphate rock and mudstone	DAB- 33	1.33	16.4	6.7	3.7	19.6	35.0	39.53	395.66	.004	.004	.112
D-15	Phosphate rock and mudstone; fos. col. no. 48-KPM-35	DAB- 34	1.16	14.6	7.9	2.6	19.0	39.0	40.69	412.60	.005	.004	.117
D-14	Mudstone, phosphatic	ERC- 35	1.2	14.0	8.8	2.5	22.5	39.1	41.89	429.40	.005	.004	.121
D-13	Mudstone and phosphate rock	ERC- 36	1.2	14.7	8.3	2.2	19.8	39.8	43.09	447.04	.005	.005	.127
D-12	Phosphate rock and mudstone; fos. col. no. 48-KPM-34	ERC- 37	1.7	18.8	6.0	2.0	25.5	23.7	44.79	479.00	.006	.005	.136
D-11	Phosphate rock	DAB- 38	0.54	32.3	2.6	1.0	7.1	11.9	45.33	496.44	.006	.005	.139
D-10	Phosphate rock and mudstone; fos. col. no. 48-KPM-33	DAB- 39	2.2	15.5	7.3	2.9	17.0	40.2	47.53	530.54	.004	.003	.145
D- 9	Mudstone	DAB- 40	0.5	6.5	10.2	3.6	8.0	72.8	48.03	533.79	.003	.002	.146
D- 8	Phosphate rock and mudstone	DAB- 41	2.4	12.3	9.5	2.6	14.2	50.7	50.43	563.31	.004	.004	.156
D- 7	Phosphate rock, argillaceous	DAB- 42	1.3	15.9	10.5	2.7	17.6	37.4	51.73	583.98	.006	.006	.164
D- 6	Mudstone and phosphate rock	DAB- 43	1.75	21.7	6.3	2.5	10.5	32.6	53.48	621.96	.006	.007	.176

<sup>1</sup> Fossil collection made by K. P. McLaughlin, Paleontology and Stratigraphy Branch, U. S. Geological Survey.



Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent $P_2O_5$ cumulative	Uranium content (percent)		Thickness x percent chem. U cumulative
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	Loss on ignition	Acid insoluble			eU	Chem. U	
D- 5	Mudstone, phosphatic	ERC- 44	1.5	10.4	9.7	3.8	14.5	56.8	54.98	637.56	.005	.006	.185
D- 4	Mudstone	ERC- 45	2.4	6.0	11.1	3.5	16.0	65.7	57.38	651.96	.005	.004	.194
D- 3	Mudstone	ERC- 46	0.8	6.6	11.9	4.4	10.4	69.5	58.18	657.24	.003	.001	.195
D- 2	Mudstone and phosphate rock	DAB- 47	1.2	15.0	8.0	7.1	5.6	46.2	59.38	675.24	.005	.004	.200
D- 1	Phosphate rock and mudstone; fos. col. no. 48-KPM-32	DAB- 48	0.5	27.0	2.0	1.7	2.4	28.7	59.88	688.74	.012	.010	.205

C member of Phosphoria formation

C-14	Sandstone, argillaceous	DAB- 49	2.9	3.4	3.7	2.9	2.5	85.9	2.9	9.86	.005	.003	.009
C-13	Sandstone	ERC- 50	2.3	3.6	3.1	1.7	9.4	68.6	5.2	18.14	.001	.002	.013
--	Sample of mudstone nodules within bed C-13	ERC-388	--	5.1	4.3	2.6	5.7	70.0	--	--	.001	.001	--
C-12	Sandstone, cherty; fos. col. no. 48-KPM-31	ERC- 51	7.2	3.2	3.0	2.5	1.6	88.1	12.4	41.18	.002	.003	.095
C-11	Chert and sandstone	ERC- 52	5.5	2.7	2.2	2.4	1.3	89.2	17.9	56.03	.002	.002	.046
C-10	Chert and sandstone	LAT- 53	15.0	0.6	2.1	2.4	1.4	94.1	32.9	65.03	.0005	.001	.061
C- 9	Chert and sandstone	LAT- 54	20.5	0.9	4.1	2.9	2.3	91.3	53.4	83.48	.0005	.001	.081
--	Mudstone	LAT-391	--	1.8	11.0	4.9	9.0	71.4	--	--	.002	.001	--
--	Mudstone, calcareous	LAT-390	--	2.0	14.3	4.8	11.8	66.9	--	--	.002	.002	--
--	Mudstone, calcareous	LAT-389	--	5.2	13.5	6.0	12.4	58.2	--	--	.001	.001	--
Lat-391, LAT-390, and LAT-389 represent three thin clay layers within bed C-9.													
C- 8	Limestone, argillaceous	LAT- 55	8.4	1.2	2.0	1.9	29.7	32.2	61.8	93.56	.001	.001	.090
C- 7	Sandstone and limestone, cherty	ERC- 56	9.2	0.5	1.3	3.4	16.0	58.8	71.0	98.16	.0005	.001	.099
C- 6	Limestone, sandy	ERC- 57	21.0	0.6	1.1	1.1	34.3	23.3	92.0	110.76	.0005	.003	.162
C- 5	Limestone, sandy, cherty	ERC- 58	6.8	3.1	3.0	1.8	26.0	35.6	98.8	131.84	.001	.001	.169
C- 4	Sandstone, cherty	DAB- 59	4.9	5.9	1.1	3.7	1.3	78.3	103.7	160.75	.002	.002	.179
--	Sandstone, cherty	DAB-392	--	3.7	0.9	2.8	1.0	90.3	--	--	.001	.002	--
DAB-392 was a grab sample of less weathered rock in bed C-4.													
C- 3	Mudstone and chert; fos. col. no. 48-KPM-30	DAB- 60	8.7	0.6	2.5	4.2	1.3	90.7	112.4	165.97	.006	.001	.187
C- 2	Chert and sandstone	DAB- 61	9.6	0.8	2.1	3.9	1.3	91.8	122.0	173.65	.0005	.001	.197
C- 1	Chert	LAT- 62	17.0	2.2	2.4	2.9	1.6	89.1	139.0	211.05	.002	.001	.214

B member of Phosphoria formation

B- 6	Mudstone, sandy	RLP-393	2.0	2.2	9.5	3.3	4.1	85.0	2.0	4.40	.002	.002	.004
B- 5	Mudstone and phosphate rock	RLP- 63	1.45	14.5	7.2	3.2	4.3	51.2	3.45	25.42	.005	.004	.010
B- 4	Mudstone	RLP-395	5.9	0.7	8.6	2.9	3.6	90.7	9.35	29.56	.001	.002	.022
B- 3	Mudstone, calcareous	RLP-394	0.7	0.8	4.2	3.9	17.2	58.9	10.05	30.12	.0005	.002	.023
B- 2	Mudstone	RLP- 64	7.4	0.3	2.8	2.6	1.5	93.0	17.45	32.34	.0005	.001	.030
B- 1	Mudstone	LAT- 65	6.5	0.2	2.1	2.5	1.3	89.0	23.95	33.64	.001	.001	.037

--	Mudstone, calcareous	LAT-396	(0.2)	0.4	16.3	3.5	14.6	61.2	--	--	.001	.001	--
	LAT-396 represents a 0.2 foot layer containing quartz crystals in bed B-1.												
A member of Phosphoria formation													
A- 2	Mudstone, calcareous	DAB- 66	6.7	0.3	4.6	2.3	17.9	60.7	6.7	2.01	.0005	.001	.007
A- 1	Limestone, argillaceous; fos. col. nos. 48-KPM-27 and 48-KPM-28	DAB- 67	10.5	0.3	3.1	2.3	24.9	47.5	17.2	5.16	.0005	.001	.017
Quadrant formation													
Cq-1	Sandstone	DAB- 68	--	0.1	2.5	2.0	1.8	98.5	--	--	.0005	.001	--

## SPECTROGRAPHIC ANALYSES—SHEEP CREEK, MONTANA. LOT NO. 1234.

Semi-quantitative analyses of samples of the Phosphoria formation, Sheep Creek, Montana (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Bureau of Mines Laboratory, Albany, Oregon. In addition to the elements listed in the table below, Sb, As, Ba, Be, Bi, Cd, Ga, Ge, Au, In, Li, Hg, Pt, Ta, Sn, and W were looked for in all samples but were not detected.

## Explanation of symbols

A = more than 10 percent      E = 0.01-0.1 percent  
 B = 5-10 percent              F = 0.001-0.01 percent  
 C = 1-5 percent                G = less than 0.001 percent  
 D = 0.1-1 percent            ND = not detected

Bed no.	Sample no.	Al	B	Ca	Cr	Co	Cb	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Si	Ag	Na	Sr	Ti	V	Zn	Zr
Trd-1	DAB- 80	C	F	A	ND	ND	ND	G	C	ND	C	E	F	F	A	ND	E	ND	E	E	E	F
E-11	DAB- 79	C	F	C	ND	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E	E	E
E-10	LAT- 78	C	E	C	F	ND	ND	G	B	ND	D	E	F	F	A	ND	E	F	E	E	ND	E
E- 9	LAT- 77	C	E	C	F	ND	ND	G	B	ND	D	E	F	F	A	ND	E	F	E	E	ND	F
E- 8	LAT- 76	D	E	C	F	ND	ND	G	B	ND	D	E	F	F	A	ND	F	F	E	E	ND	F
E- 7	ERC- 75	C	F	C	E	ND	ND	G	C	ND	D	E	F	E	A	ND	F	ND	E	E	E	F
E- 6	ERC- 74	C	F	C	E	ND	ND	G	C	ND	D	E	F	E	A	ND	E	ND	E	E	E	F
E- 5	ERC- 73	C	F	C	E	ND	ND	G	C	ND	D	E	F	E	A	ND	F	ND	E	E	E	F
E- 4	DAB- 72	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E	E	F
E- 3	DAB- 71	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E	E	F
E- 2	DAB- 70	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E	E	F
E- 1	DAB- 69	C	F	A	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E	E	F
D-48	VEM- 1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D-47	VEM- 2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D-46	VEM- 3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D-45	VEM- 4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D-44	JES - 5	C	F	D	D	ND	ND	G	C	ND	D	E	E	E	A	F	E	ND	E	D	E	E
D-43	JES - 6	C	F	D	D	ND	ND	G	C	ND	D	E	E	E	A	F	E	ND	D	D	E	E
D-42	JES - 7	C	F	A	D	ND	ND	G	C	ND	D	E	E	E	A	F	E	ND	D	D	E	E
D-41	JES - 8	C	F	B	D	ND	ND	G	C	ND	D	E	E	E	A	F	E	ND	D	D	E	E
D-40	OAP- 9	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	E	D	D	E	E
--	OAP-385	B	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	E	D	E	E	E
D-39	OAP- 10	B	E	C	E	ND	ND	G	B	ND	C	E	E	E	A	G	E	F	D	E	E	E
D-38	OAP- 11	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	F	D	E	E	E
D-37	OAP- 12	C	F	C	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	F	D	E	E	E
D-36	OAP- 13	B	F	A	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	E	D	E	E	E
D-35	LAT- 14	C	F	A	D	ND	ND	G	C	ND	D	E	E	E	A	F	E	ND	E	D	E	E

RESTRICTED

--	LAT-386	C	F	A	E	ND	ND	G	C	ND	D	F	F	F	A	F	E	E	E	E
D-34	FSH- 15	C	F	A	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	E	E	E
D-33	FSH- 16	C	F	A	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	E	E	E
D-32	FSH- 17	C	F	A	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	E	E	E
D-31	FSH- 18	C	F	A	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	E	E	E
D-30	FSH- 19	C	F	C	D	ND	ND	G	C	ND	D	E	E	E	A	F	E	ND	D	D
D-29	ERC- 20	C	F	D	E	ND	ND	G	C	ND	C	F	E	E	A	F	E	ND	D	D
D-28	LAT- 21	C	F	D	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	D	D
D-27	LAT- 22	C	E	D	D	ND	E	G	B	ND	D	E	E	E	A	F	E	F	D	D
D-26	LAT- 23	B	E	D	D	ND	E	G	B	ND	D	F	E	E	A	F	E	F	D	D
D-25	LAT- 24	C	E	E	D	ND	E	G	B	ND	D	E	E	E	A	F	E	F	D	D
D-24	ERC- 25	C	F	D	E	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	D	D
--	ERC-387	C	F	D	D	ND	ND	G	C	ND	C	F	E	E	A	F	E	ND	D	D
D-23	ERC- 26	C	F	D	E	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	D	D
D-22	ERC- 27	C	F	D	E	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	D	D
D-21	ERC- 28	C	F	C	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	ND	E	D
D-20	LAT- 29	C	F	A	D	ND	E	G	C	ND	D	F	E	E	A	F	D	E	E	D
D-19	LAT- 30	C	F	A	E	ND	E	G	C	ND	D	F	E	E	A	F	D	E	E	D
D-18	LAT- 31	C	F	A	D	ND	E	G	C	ND	D	F	E	E	A	F	D	E	E	D
D-17	DAB- 32	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	E	D
D-16	DAB- 33	C	F	A	E	ND	ND	G	C	ND	D	E	E	E	A	G	E	ND	E	D
D-15	DAB- 34	C	F	A	E	ND	ND	G	C	ND	D	E	E	E	A	G	E	ND	E	D
D-14	ERC- 35	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	ND	E	D
D-13	ERC- 36	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	ND	E	D
D-12	ERC- 37	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	G	E	ND	E	D
D-11	DAB- 38	C	F	A	E	ND	ND	G	C	ND	D	E	F	E	A	G	E	ND	E	ND
D-10	DAB- 39	C	F	A	E	ND	ND	G	C	ND	D	E	E	E	A	G	E	ND	E	E
D- 9	DAB- 40	C	F	C	E	ND	ND	G	C	ND	D	E	E	E	A	G	E	ND	E	E
D- 8	DAB- 41	C	F	A	D	ND	ND	G	C	E	D	E	E	E	A	G	E	ND	E	D
D- 7	DAB- 42	C	F	A	D	ND	ND	G	C	E	D	E	E	E	A	F	E	ND	E	D
D- 6	DAB- 43	C	F	A	E	ND	ND	G	C	ND	D	E	E	F	A	F	E	ND	E	E
D- 5	ERC- 44	C	F	A	E	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	E	D
D- 4	ERC- 45	C	F	C	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	E	D
D- 3	ERC- 46	C	F	C	D	ND	ND	G	C	ND	D	F	E	E	A	F	E	ND	E	D
D- 2	DAB- 47	C	F	A	E	ND	ND	G	C	E	D	F	E	E	A	F	E	ND	E	D
D- 1	DAB- 48	C	F	A	E	ND	ND	G	C	ND	D	E	F	F	A	G	E	ND	E	E
C-14	DAB- 49	C	F	A	E	ND	ND	G	C	ND	D	E	F	F	A	G	E	ND	E	E
C-13	ERC- 50	C	F	B	E	ND	ND	G	C	ND	C	D	C	D	A	ND	E	ND	E	E
--	ERC-388	C	F	C	E	E	E	G	C	ND	D	C	E	E	A	G	E	ND	E	E
C-12	ERC- 51	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E
C-11	ERC- 52	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E
C-10	LAT- 53	C	F	D	F	ND	ND	G	B	ND	E	E	F	E	A	G	E	F	E	E
C- 9	LAT- 54	C	F	D	F	ND	ND	G	B	ND	D	E	E	E	A	G	E	F	E	E
--	LAT-391	B	F	C	E	F	E	G	B	ND	C	E	E	E	A	G	E	F	E	E



Bed no.	Sample no.	Al	B	Ca	Cr	Co	Cb	Cu	Fe	Pb	Mg	Mn	Mo	Ni	Si	Ag	Na	Sr	Ti	V	Zn	Zr
--	LAT-390	B	F	C	E	F	E	G	A	ND	C	D	F	D	A	G	E	F	D	E	D	E
--	LAT-389	B	F	C	E	E	E	G	A	ND	C	D	F	E	A	G	E	F	D	E	E	E
C- 8	LAT- 55	C	F	A	F	ND	ND	G	C	ND	A	E	F	E	A	G	E	F	E	E	E	E
C- 7	ERC- 56	C	F	B	E	ND	ND	G	C	ND	A	E	F	E	A	ND	F	ND	E	E	E	F
C- 6	ERC- 57	C	F	A	E	ND	ND	G	C	ND	B	E	F	E	A	ND	F	ND	E	E	E	F
C- 5	ERC- 58	C	F	A	E	ND	ND	G	C	ND	B	E	F	E	A	ND	F	ND	E	E	E	F
C- 4	DAB- 59	C	F	B	E	ND	ND	G	C	ND	D	E	F	F	A	G	E	ND	E	E	E	F
--	DAB-392	C	F	C	ND	ND	ND	G	C	ND	D	E	F	E	A	ND	E	ND	E	E	E	F
C- 3	DAB- 60	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	G	E	ND	E	E	E	F
C- 2	DAB- 61	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	G	E	ND	E	E	E	F
C- 1	LAT- 62	C	F	C	F	ND	ND	G	B	E	E	E	F	E	A	G	E	F	E	E	E	E
B- 6	RLP-393	B	F	C	E	F	E	G	B	E	D	F	F	E	A	F	E	F	D	E	E	E
B- 5	RLP- 63	C	F	A	E	ND	ND	G	C	D	D	E	F	E	A	F	D	F	E	E	E	E
B- 4	RLP-395	C	F	D	F	F	ND	G	B	ND	D	E	F	E	A	G	F	F	E	E	E	E
B- 3	RLP-394	C	F	C	E	F	ND	G	B	ND	C	D	F	E	A	G	E	F	E	E	E	E
B- 2	RLP- 64	C	F	D	F	ND	ND	G	B	ND	D	E	F	E	A	G	E	F	E	E	D	E
B- 1	LAT- 65	B	E	D	F	F	ND	G	B	ND	D	E	F	E	A	G	E	F	D	E	E	E
--	LAT-396	B	F	C	F	F	E	G	A	ND	C	D	F	E	A	G	E	F	E	E	D	E
A- 2	DAB- 66	C	F	A	E	ND	ND	G	C	ND	C	E	F	F	A	ND	E	ND	E	E	E	F
A- 1	DAB- 67	C	F	A	E	ND	ND	G	C	ND	C	E	F	F	A	ND	E	ND	E	E	E	F
Cq-1	DAB- 68	C	F	C	E	ND	ND	G	C	ND	D	E	F	F	A	ND	E	ND	E	E	E	F

## OIL SHALE ANALYSES—SHEEP CREEK, MONTANA. LOT NO. 1234.

Oil shale analyses of samples of the D member of the Phosphoria formation, Sheep Creek, Montana (see immediately preceding pages for location of section, thickness and description of strata, and chemical analyses of samples), made by U. S. Bureau of Mines Petroleum and Oil-Shale Experiment Station, Laramie, Wyoming, by the modified Fischer-Retort method. None of the samples showed a tendency to coke.

Bed no.	Sample no.	Yield of products						Specific gravity of oil at 60°/60°F.	Properties of spent shale Percent of original shale	
		Weight (percent)				Gallons per ton			Loss on ignition	Ash
		Oil	Water	Spent shale	Gas+loss	Oil	Water			
D-48	VEM- 1	--	3.8	95.1	1.1	--	9.1	--	3.6	91.5
D-47	VEM- 2	--	4.2	94.0	1.8	--	10.1	--	4.3	89.7
D-46	VEM- 3	--	4.6	93.2	2.2	--	11.0	--	4.2	89.0
D-45	VEM- 4	--	4.0	94.4	1.6	--	9.6	--	4.9	89.5
D-44	JES- 5	--	6.5	91.3	2.2	--	15.6	--	5.3	86.0
D-43	JES- 6	--	4.8	93.3	1.9	--	11.5	--	5.5	87.8
D-42	JES- 7	--	5.4	92.9	1.7	-- <sup>1</sup>	12.9	--	5.0	87.9
D-41	JES- 8	0.5	5.8	91.6	2.1	1.3 <sup>1</sup>	13.9	--	6.8	84.8
D-40	OAP- 9	--	3.5	95.7	0.8	--	8.4	--	3.5	92.2
--	OAP-385	--	3.2	95.7	1.1	--	7.7	--	3.5	92.2
D-39	OAP- 10	1.0	6.4	90.1	2.5	2.6 <sup>1</sup>	15.3	--	7.3	82.8
D-38	OAP- 11	0.7	5.0	91.7	2.6	1.8 <sup>1</sup>	12.0	--	6.4	85.3
D-37	OAP- 12	--	6.2	91.9	1.9	--	14.9	--	6.2	85.7
D-36	OAP- 13	--	5.2	92.5	2.3	--	12.5	--	6.3	86.2
D-35	LAT- 14	--	3.1	96.1	0.8	--	7.4	--	4.8	91.3
--	LAT-386	0.4	3.4	94.8	1.4	0.9 <sup>1</sup>	8.1	--	4.7	90.1
D-34	FSH- 15	--	3.8	94.1	2.1	--	9.1	--	4.3	89.8
D-33	FSH- 16	--	4.5	93.9	1.6	--	10.8	--	4.1	89.8
D-32	FSH- 17	--	5.5	92.1	2.4	--	13.2	--	6.4	85.7
D-31	FSH- 18	--	3.4	95.1	1.5	--	8.1	--	4.2	90.9
D-30	FSH- 19	--	7.5	89.4	3.1	--	18.0	--	7.9	81.5
D-29	FSH- 20	2.9	5.6	88.9	2.6	7.0	13.4	0.986	9.9	79.0
D-28	ERC- 21	--	7.0	89.6	3.4	--	16.8	--	7.8	81.8
D-27	LAT- 22	8.2	5.2	82.7	3.9	20.0	12.5	0.989	12.5	70.2
D-26	LAT- 23	7.8	6.0	82.9	3.3	18.8	14.4	0.990	14.8	68.1
D-25	LAT- 24	5.3	4.4	87.8	2.5	12.8	10.5	0.990	10.1	77.7
D-24	ERC- 25	1.9	7.7	87.3	3.1	4.7 <sup>1</sup>	18.6	--	10.4	76.9
--	ERC-387	2.6	6.5	85.7	5.2	6.6 <sup>1</sup>	15.6	--	10.7	75.0
D-23	ERC- 26	9.7	4.3	82.7	3.3	23.6	10.3	0.989	14.2	68.5
D-22	ERC- 27	3.2	7.2	85.8	3.8	7.8	17.3	0.990	11.9	73.9

<sup>1</sup> Estimated

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Bed no.	Sample no.	Yield of products						Specific gravity of oil at 60°/60° F.	Properties of spent shale Percent of original shale	
		Weight (percent)				Gallons per ton			Loss on ignition	Ash
		Oil	Water	Spent shale	Gas+ loss	Oil	Water			
D-21	ERC- 28	7.8	5.6	81.3	5.3	18.9	13.4	0.991	13.0	68.3
D-20	LAT- 29	--	7.5	91.1	1.4	--	18.0	--	6.1	85.0
D-19	LAT- 30	--	4.2	94.4	1.4	--	10.2	--	6.0	88.4
D-18	LAT- 31	1.9	5.3	89.8	3.0	4.8 <sup>1</sup>	12.7	--	8.0	81.8
D-17	DAB- 32	3.2	5.0	89.0	2.8	7.6	12.0	1.002	7.8	81.2
D-16	DAB- 33	3.3	5.0	88.8	2.9	8.4 <sup>1</sup>	12.0	--	9.2	79.6
D-15	DAB- 34	3.7	4.8	88.8	2.7	8.9	11.5	0.994	9.0	79.8
D-14	ERC- 35	4.3	5.6	87.0	3.1	10.4	13.4	0.990	9.4	77.6
D-13	ERC- 36	3.7	5.2	87.7	3.4	8.9	12.5	0.986	9.8	77.9
D-12	ERC- 37	5.5	5.0	86.6	2.9	13.4	12.0	0.990	9.0	77.6
D-11	DAB- 38	--	3.0	96.7	0.3	--	7.2	--	3.4	93.3
D-10	DAB- 39	2.5	5.4	89.9	2.2	6.4 <sup>1</sup>	12.9	--	8.0	81.9
D- 9	DAB- 40	0.8	5.7	92.6	0.9	1.9 <sup>1</sup>	13.7	--	3.4	89.2
D- 8	DAB- 41	--	4.8	94.8	0.4	--	11.4	--	6.4	88.4
D- 7	DAB- 42	--	8.5	91.1	0.4	--	20.4	--	7.2	83.9
D- 6	DAB- 43	--	5.5	93.1	1.4	--	13.2	--	5.1	88.0
D- 5	ERC- 44	--	7.5	89.7	2.8	--	18.0	--	8.0	81.7
D- 4	ERC- 45	--	8.0	88.8	3.2	--	19.2	--	7.6	81.2
D- 3	ERC- 46	--	5.5	94.2	0.3	--	13.2	--	3.8	90.4
D- 2	DAB- 47	--	3.2	96.5	0.3	--	7.7	--	2.2	94.3
D- 1	DAB- 48	--	1.5	98.5	0.0	--	3.6	--	1.6	96.9

<sup>1</sup> Estimated

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## CEDAR CREEK, MONTANA. LOT NO. 1256.

D member of Phosphoria formation sampled in bulldozer trench near Cedar Creek, sec. 26, T. 9 S., R. 11 W., Beaverhead County, Montana, on eastern limb of a syncline. Beds strike north and dip 61° W. Section measured by E. T. Ruppel and sampled by J. A. Kelleher in August 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—basal bed only										
E- 1	Chert	ETR-585	5.0	2.3	78.5	5.0	11.50	.0005	--	.003
D member of Phosphoria formation—base not exposed										
D-43	Mudstone	ETR-584	11.5	1.0	74.0	11.5	11.50	.001	--	.011
D-42	Mudstone	ETR-583	10.0	1.1	82.3	21.5	22.50	.001	--	.021
D-41	Phosphate rock, cherty, calcareous	ETR-582	0.8	15.4	34.2	22.3	34.82	.007	.005	.027
D-40	Limestone, phosphatic, argillaceous	ETR-581	0.3	11.4	22.7	22.6	38.24	.005	.005	.029
D-39	Mudstone	ETR-580	1.5	4.6	62.6	24.1	45.14	.004	--	.035
D-38	Mudstone, calcareous, phosphatic	ETR-579	0.3	9.2	42.2	24.4	47.90	.005	.004	.036
D-37	Mudstone	ETR-578	3.0	2.0	77.6	27.4	53.90	.004	--	.048
D-36	Mudstone and calcareous phosphate rock	ETR-577	1.0	9.6	51.0	28.4	63.50	.006	.004	.054
D-35	Mudstone, calcareous and phosphate rock	ETR-576	0.7	6.3	42.8	29.1	67.91	.004	--	.057
D-34	Limestone	ETR-575	1.2	1.8	48.3	30.3	70.07	.001	--	.058
D-33	Mudstone, calcareous	ETR-574	1.2	7.6	12.7	31.5	79.19	.005	.003	.064
D-32	Phosphate rock, calcareous	ETR-573	1.0	17.4	19.6	32.5	96.59	.005	.004	.069
D-31	Phosphate rock, calcareous	ETR-572	0.8	21.0	2.6	33.3	113.39	.004	--	.072
D-30	Mudstone	ETR-571	0.9	1.4	72.0	34.2	114.65	.003	--	.075
D-29	Phosphate rock, argillaceous	ETR-570	0.15	18.9	33.5	34.35	117.49	.004	--	.076
D-28	Phosphate rock; fos. col. no. 48-KPM-48 <sup>1</sup>	ETR-569	0.7?	32.6	25.0	35.05	140.31	.006	.006	.080
D-27	Phosphate rock, argillaceous	ETR-568	0.3	23.5	26.8	35.35	147.36	.006	.004	.082
D-26	Mudstone	ETR-567	0.7	5.7	64.7	36.05	151.35	.004	--	.084
D-25	Phosphate rock, argillaceous	ETR-566	0.1	20.9	33.0	36.15	153.44	.006	.005	.085
D-24	Phosphate rock, argillaceous	ETR-565	0.3	17.5	35.8	36.45	158.69	.005	.005	.087
D-23	Phosphate rock, argillaceous	ETR-564	0.4	22.1	24.3	36.85	167.53	.007	.006	.089
D-22	Limestone, argillaceous	ETR-563	0.5	3.5	39.1	37.35	169.28	.003	--	.091
D-21	Mudstone, calcareous, phosphatic	ETR-562	0.5	9.8	41.4	37.85	174.18	.004	--	.093
D-20	Mudstone, phosphatic	ETR-561	0.4	8.9	58.3	38.25	177.74	.004	--	.094
D-19	Phosphate rock and calcareous mudstone; fos. col. no. 48-KPM-47	ETR-560	0.5	24.8	20.3	38.75	190.14	.006	.005	.097
D-18	Phosphate rock, argillaceous	ETR-559	0.6	22.8	27.0	39.35	203.82	.007	.006	.102

<sup>1</sup> Fossil collection made by K. P. McLaughlin, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

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Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
D-17	Phosphate rock, argillaceous, and calcareous mudstone	ETR-558	0.9	20.3	26.6	40.25	222.09	.005	.004	.106
D-16	Mudstone, phosphatic	ETR-557	0.25	10.1	55.0	40.50	224.61	.004	--	.107
D-15	Mudstone, calcareous	ETR-556	0.9	2.9	58.9	41.40	227.22	.002	--	.109
D-14	Phosphate rock, calcareous; fos. col. no. 48-KPM-46	ETR-555	0.3	25.1	17.6	41.70	234.75	.006	.005	.111
D-13	Mudstone, phosphatic	ETR-554	0.3	9.9	56.1	42.00	237.72	.005	.003	.112
D-12	Mudstone, phosphatic	ETR-553	0.6	12.4	52.1	42.60	245.16	.005	.003	.115
D-11	Phosphate rock and limestone	ETR-552	0.9	16.8	3.8	43.50	260.28	.006	.004	.121
D-10	Phosphate rock, calcareous	ETR-551	0.4	20.8	17.7	43.90	268.60	.005	.005	.123
D-9	Mudstone, phosphatic	ETR-550	0.25	14.1	46.5	44.15	272.12	.006	.004	.124
D-8	Phosphate rock, argillaceous	ETR-549	0.33	19.7	30.2	44.48	278.62	.005	.004	.126
D-7	Phosphate rock, argillaceous	ETR-548	0.2	21.5	30.6	44.68	282.92	.006	.004	.127
D-6	Mudstone, calcareous	ETR-547	0.6	6.6	49.8	45.28	286.88	.003	--	.129
D-5	Mudstone	ETR-546	0.5	1.7	79.4	45.78	287.73	.003	--	.130
D-4	Mudstone, calcareous	ETR-545	0.6	6.7	62.0	46.38	291.75	.005	.003	.133
D-3	Phosphate rock and mudstone	ETR-544	1.1	16.5	40.3	47.48	309.90	.005	.004	.139
D-2	Mudstone, phosphatic	ETR-543	0.35	8.2	51.1	47.83	212.77	.002	--	.140
D-1	Phosphate rock, sandy; fos. col. no. 48-KPM-44	ETR-542	3.0	26.3	28.6	50.83	291.67	.007	.006	.061

Stratigraphic interval of 286 feet between D-1 and approximate base of C member, includes few exposures of chert and limestone or dolomite.

Stratigraphic interval of 123 feet between approximate base of C member and approximate top of Quadrant formation, strata concealed.

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## SAWTOOTH PEAK, MONTANA. LOT NO. 1241.

C and E members and part of A member of Phosphoria formation measured in natural exposures, and B and D members sampled from hand trenches on Sawtooth Peak, NE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 10, T. 12 S., R. 5 W., Beaverhead County, Montana, on overturned east limb of Snowcrest anticline. Beds at top of section strike N. 5° W. and dip 75° W. Beds at base of section strike N. 40° E. and dip 64° SE. Section measured by F. S. Honkala and O. A. Payne and sampled by Payne in August 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation										
Td-2	Not described; fos. col. no. 48-KPM-77 <sup>1</sup>	--	18.0	--	--	--	--	--	--	--
Td-1	Mudstone, quartzitic	--	5.0	--	--	5.0	--	--	--	--
E member of Phosphoria formation										
E-15	Quartzite	--	2.4	--	--	2.4	--	--	--	--
E-14	Sandstone	--	4.3	--	--	6.7	--	--	--	--
E-13	Quartzite	--	5.0	--	--	11.7	--	--	--	--
E-12	Quartzite	--	5.0	--	--	16.7	--	--	--	--
E-11	Sandstone	--	2.8	--	--	19.5	--	--	--	--
E-10	Sandstone	--	5.0	--	--	24.5	--	--	--	--
E- 9	Sandstone	--	5.0	--	--	29.5	--	--	--	--
E- 8	Quartzite	--	3.4	--	--	32.9	--	--	--	--
E- 7	Quartzite	--	5.0	--	--	37.9	--	--	--	--
E- 6	Quartzite	--	5.0	--	--	42.9	--	--	--	--
E- 5	Sandstone, quartzitic	--	5.0	--	--	47.9	--	--	--	--
E- 4	Quartzite	--	3.8	--	--	51.7	--	--	--	--
E- 3	Sandstone, quartzitic	--	5.0	--	--	57.7	--	--	--	--
E- 2	Sandstone, quartzitic	--	5.0	--	--	61.7	--	--	--	--
E- 1	Conglomerate and quartzite	--	5.0	--	--	66.7	--	--	--	--
D member of Phosphoria formation										
D-14	Phosphate rock and quartzite	FSH-438	3.5	7.4	77.7	3.5	25.90	.002	.001	.004
D-13	Phosphate rock and mudstone	FSH-437	2.8	14.7	51.7	6.3	67.06	.003	.003	.012
D-12	Mudstone	FSH-436	4.6	4.7	63.1	10.9	88.68	.004	.002	.021
D-11	Phosphate rock and mudstone	FSH-435	2.5	20.9	27.5	13.4	140.93	.007	.006	.036
D-10	Mudstone, phosphatic, calcareous	FSH-434	5.0	7.9	50.7	18.4	180.43	.005	.003	.051
D- 9	Mudstone and phosphate rock, argillaceous, calcareous	FSH-433	5.0	16.3	33.8	23.4	261.93	.007	.005	.076

<sup>1</sup> Fossil collection made by K. P. McLaughlin, Paleontology and Stratigraphy Branch, U. S. Geological Survey, from bed 16.3 feet above base of formation.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				$P_2O_5$	Acid insoluble			eU	Chem. U	
D- 8	Phosphate rock and mudstone	FSH-432	2.3	16.9	35.4	25.7	300.80	.007	.005	.088
D- 7	Limestone; fos. col. no. 48-KPM-76	FSH-431	2.9	6.9	18.7	28.6	320.81	.003	.002	.093
D- 6	Mudstone	FSH-430	3.2	0.2	85.7	31.8	321.45	.002	.001	.097
D- 5	Mudstone	FSH-429	5.0	0.3	84.9	36.8	322.95	.002	.001	.102
D- 4	Mudstone	FSH-428	5.0	0.4	83.7	41.8	324.95	.002	.001	.107
D- 3	Mudstone	FSH-427	5.0	0.3	87.3	46.8	326.45	.002	.001	.112
D- 2	Mudstone	FSH-426	5.0	0.4	83.3	51.8	328.45	.002	.001	.117
D- 1	Mudstone	FSH-425	5.0	0.2	86.3	56.8	329.45	.002	.001	.122

C member of Phosphoria formation

C-60	Chert	--	2.3	--	--	2.3	--	--	--	--
C-59	Sandstone	--	4.3	--	--	6.6	--	--	--	--
C-58	Sandstone	--	5.0	--	--	11.6	--	--	--	--
C-57	Sandstone	--	2.0	--	--	13.6	--	--	--	--
C-56	Sandstone	FSH-424	1.8	3.6	86.7	15.4	--	.0005	.001	--
C-55	Sandstone, quartzitic	--	3.3	--	--	18.7	--	--	--	--
C-54	Quartzite	--	3.2	--	--	21.9	--	--	--	--
C-53	Chert and mudstone	--	2.7	--	--	24.6	--	--	--	--
C-52	Conglomerate, cherty	--	0.6	--	--	25.2	--	--	--	--
C-51	Chert	--	4.0	--	--	29.2	--	--	--	--
--	Covered interval, float strongly suggests limestone	--	11.0	--	--	40.2	--	--	--	--
C-50	Limestone	--	5.0	--	--	45.2	--	--	--	--
C-49	Limestone	--	5.0	--	--	50.2	--	--	--	--
C-48	Limestone	--	5.0	--	--	55.2	--	--	--	--
C-47	Limestone	--	5.0	--	--	60.2	--	--	--	--
C-46	Limestone	--	2.5	--	--	62.7	--	--	--	--
C-45	Limestone	--	5.0	--	--	67.7	--	--	--	--
C-44	Limestone	--	2.6	--	--	70.3	--	--	--	--
C-43	Limestone; fos. col. no. 48-KPM-75	--	5.0	--	--	75.3	--	--	--	--
C-42	Limestone	--	5.0	--	--	80.3	--	--	--	--
C-41	Limestone	--	5.0	--	--	85.3	--	--	--	--
C-40	Limestone	--	5.0	--	--	90.3	--	--	--	--
C-39	Limestone and dolomite	--	5.0	--	--	95.3	--	--	--	--
C-38	Chert	--	1.1	--	--	96.4	--	--	--	--
C-37	Dolomite	--	3.5	--	--	99.9	--	--	--	--
C-36	Dolomite	--	5.0	--	--	104.9	--	--	--	--
C-35	Dolomite	--	5.0	--	--	109.9	--	--	--	--

C-34	Dolomite	--	1.6	--	--	111.5	--	--	--	--
C-33	Limestone; fos. col. no. 48-KPM-74	--	4.2	--	--	115.7	--	--	--	--
C-32	Limestone and chert	--	5.0	--	--	120.7	--	--	--	--
C-31	Limestone and chert	--	5.0	--	--	125.7	--	--	--	--
C-30	Limestone and chert	--	5.0	--	--	130.7	--	--	--	--
C-29	Limestone	--	3.0	--	--	133.7	--	--	--	--
C-28	Limestone	--	5.0	--	--	138.7	--	--	--	--
C-27	Limestone	--	5.0	--	--	143.7	--	--	--	--
C-26	Limestone	--	5.0	--	--	148.7	--	--	--	--
C-25	Limestone	--	5.0	--	--	153.7	--	--	--	--
C-24	Limestone	--	5.0	--	--	158.7	--	--	--	--
C-23	Limestone, sandy	--	5.0	--	--	163.7	--	--	--	--
C-22	Limestone, sandy	--	3.4	--	--	167.1	--	--	--	--
C-21	Limestone, dolomitic, sandy?	--	3.7	--	--	170.8	--	--	--	--
C-20	Chert	--	3.5	--	--	174.3	--	--	--	--
C-19	Sandstone, calcareous	--	1.4	--	--	175.7	--	--	--	--
C-18	Chert, sandy, calcareous	--	1.8	--	--	177.5	--	--	--	--
C-17	Chert, sandy	--	4.4	--	--	181.9	--	--	--	--
C-16	Chert, sandy	--	5.0	--	--	186.9	--	--	--	--
C-15	Chert, sandy	--	5.0	--	--	191.9	--	--	--	--
C-14	Chert, sandy	--	5.0	--	--	196.9	--	--	--	--
C-13	Chert, sandy	--	5.0	--	--	201.9	--	--	--	--
C-12	Chert, sandy	--	5.0	--	--	206.9	--	--	--	--
C-11	Chert, sandy	--	5.0	--	--	211.9	--	--	--	--
C-10	Chert, sandy	--	5.0	--	--	216.9	--	--	--	--
C- 9	Chert	--	5.0	--	--	221.9	--	--	--	--
C- 8	Chert	--	4.8	--	--	226.7	--	--	--	--
C- 7	Sandstone and chert	--	4.0	--	--	230.7	--	--	--	--
C- 6	Chert	--	3.8	--	--	234.5	--	--	--	--
C- 5	Chert	--	5.0	--	--	239.5	--	--	--	--
C- 4	Chert	--	5.0	--	--	244.5	--	--	--	--
C- 3	Chert	--	5.0	--	--	249.5	--	--	--	--
C- 2	Chert	--	5.0	--	--	254.5	--	--	--	--
C- 1	Chert, argillaceous	--	5.0	--	--	259.5	--	--	--	--

B member of Phosphoria formation

B- 6	Mudstone and phosphate rock	FSH-423	3.1	4.0	80.8	3.1	12.40	.003	.002	.006
B- 5	Mudstone and phosphate rock	FSH-422	3.6	5.2	73.6	6.7	31.12	.004	.002	.013
B- 4	Mudstone	FSH-421	2.8	7.0	60.1	9.5	50.72	.004	.002	.019
B- 3	Phosphate rock	FSH-420	2.7	27.6	12.7	12.2	125.24	.009	.007	.038
B- 2	Limestone, phosphatic, sandy; fos. col. no. 48-KPM-73	FSH-419	1.2	10.2	24.0	13.4	137.48	.003	.001	.039
B- 1	Phosphate rock, sandy; fos. col. no. 48-KPM-72	FSH-418	2.8	23.5	30.3	16.2	203.28	.007	.006	.056



Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				$P_2O_5$	Acid insoluble			eu	Chem. U	
A member of Phosphoria formation—base not exposed										
A-16	Chert	--	1.8	--	--	1.8	--	--	--	--
A-15	Dolomite, argillaceous; fos. col. no. 48-KPM-71	--	4.2	--	--	6.0	--	--	--	--
A-14	Mudstone and sandstone, calcareous	--	4.6	--	--	10.6	--	--	--	--
A-13	Sandstone, calcareous, argillaceous	--	2.6	--	--	13.2	--	--	--	--
A-12	Sandstone, calcareous, argillaceous	--	5.0	--	--	18.2	--	--	--	--
A-11	Sandstone, calcareous	--	5.0	--	--	23.2	--	--	--	--
A-10	Sandstone, calcareous	--	5.0	--	--	28.2	--	--	--	--
A- 9	Sandstone, calcareous	--	5.0	--	--	33.2	--	--	--	--
A- 8	Sandstone, calcareous	--	5.0	--	--	38.2	--	--	--	--
A- 7	Sandstone, calcareous, argillaceous	--	3.7	--	--	41.9	--	--	--	--
A- 6	Dolomite, argillaceous	--	5.0	--	--	46.9	--	--	--	--
A- 5	Dolomite, argillaceous	--	5.0	--	--	51.9	--	--	--	--
A- 4	Dolomite, sandy	--	5.0	--	--	56.9	--	--	--	--
A- 3	Dolomite, sandy	--	5.0	--	--	61.9	--	--	--	--
A- 2	Dolomite, sandy	--	5.0	--	--	66.9	--	--	--	--
A- 1	Dolomite, sandy	--	5.0	--	--	71.9	--	--	--	--

## HIDDEN PASTURE CREEK, MUDDY CREEK, AND BIG SHEEP CANYON, MONTANA. LOT NOS. 1224, 1225, 1226 and 1227.

Phosphoria formation sampled in hand trenches and natural exposures on east limb of Dixon Mountain syncline; D and E members, lot no. 1224, sampled in NE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 26; B and C members, lot no. 1225, in SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 35; and upper part of A member, lot no. 1226, in NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 35, T. 13 S., R. 10 W.; lower part of A member, lot no. 1227, sampled in NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 11, T. 14 S., R. 10 W., Beaverhead County, Montana. Beds strike northwest and dip 30-40° SW. Section measured by W. R. Lowell and sampled by D. A. Bostwick, E. T. Ruppel, and R. L. Parker in August 1947. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)							Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F	Loss on ignition	Acid insoluble			eU	Chem. U	
Dinwoody formation—not measured															
E member of Phosphoria formation, lot no. 1224															
E-34	Mudstone	--	25.0	--	--	--	--	--	--	--	25.0	--	--	--	--
E-33	Mudstone, cherty	WRL-222-47	3.5	1.5	--	--	--	--	--	78.9	28.5	5.25	.0005	--	.002
E-32	Mudstone, cherty	WRL-221-47	4.0	1.3	--	--	--	--	--	71.7	32.5	10.45	.001	--	.006
E-31	Mudstone, cherty	WRL-220-47	5.0	1.3	--	--	--	--	--	74.6	37.5	16.95	.001	--	.011
E-30	Mudstone, cherty	WRL-219-47	4.2	1.8	--	--	--	--	--	74.6	41.7	24.51	.0005	--	.013
E-29	Mudstone, cherty	WRL-218-47	4.2	1.2	--	--	--	--	--	75.5	45.9	29.55	.001	--	.017
E-28	Mudstone, calcareous	WRL-217-47	0.8	0.9	--	--	--	--	--	66.6	46.7	30.27	.0005	--	.017
E-27	Mudstone, calcareous	WRL-216-47	1.3	1.9	--	--	--	--	--	75.3	48.0	32.74	.001	--	.019
E-26	Quartzite	WRL-215-47	4.6	1.2	--	--	--	--	--	76.1	52.6	38.26	.0005	--	.021
E-25	Chert	WRL-214-47	5.0	0.6	--	--	--	--	--	80.9	57.6	41.26	.0005	--	.024
E-24	Chert	WRL-213-47	5.0	1.0	--	--	--	--	--	80.3	62.6	46.26	.0005	--	.026
E-23	Chert and mudstone	WRL-212-47	4.7	1.2	--	--	--	--	--	80.3	67.3	51.90	.0005	--	.028
E-22	Chert	WRL-211-47	5.0	1.5	--	--	--	--	--	78.9	72.3	59.40	.001	--	.033
E-21	Chert	WRL-210-47	1.7	1.4	--	--	--	--	--	85.0	74.0	61.78	.0005	--	.034
E-20	Chert	WRL-209-47	4.4	2.2	--	--	--	--	--	77.8	78.4	71.46	.001	--	.039
E-19	Limestone	WRL-208-47	0.8	0.5	--	--	--	--	--	3.0	79.2	71.86	.0005	--	.039
E-18	Chert	WRL-207-47	4.9	1.3	--	--	--	--	--	74.3	84.1	78.23	.002	--	.049
E-17	Chert	WRL-206-47	4.5	1.6	--	--	--	--	--	75.5	88.6	85.43	.002	--	.058
E-16	Chert	WRL-205-47	1.9	1.3	--	--	--	--	--	85.7	90.5	87.90	.0005	--	.059
E-15	Limestone	WRL-204-47	1.0	0.5	--	--	--	--	--	1.4	91.5	88.40	.0005	--	.059
E-14	Chert	WRL-203-47	2.2	1.5	--	--	--	--	--	76.4	93.7	91.70	.001	--	.062
E-13	Chert	WRL-202-47	5.0	1.4	--	--	--	--	--	78.7	98.7	98.70	.001	--	.067
E-12	Chert	WRL-201-47	2.2	1.5	--	--	--	--	--	76.7	100.9	102.00	.002	--	.071
E-11	Chert and limestone	WRL-200-47	2.5	0.9	--	--	--	--	--	75.5	103.4	104.25	.0005	--	.072
E-10	Chert	WRL-199-47	2.7	1.4	--	--	--	--	--	80.4	106.1	108.03	.001	--	.075
E-9	Mudstone	WRL-107-47	5.0	1.2	--	--	--	--	--	78.4	111.1	114.03	.001	--	.080
E-8	Chert	WRL-106-47	5.0	1.6	--	--	--	--	--	8.9	116.1	122.03	.001	--	.085
E-7	Mudstone	WRL-105-47	5.0	1.6	--	--	--	--	--	80.2	121.1	130.03	.001	--	.090
E-6	Mudstone	WRL-104-47	5.0	1.3	--	--	--	--	--	77.4	126.1	136.53	.002	--	.100
E-5	Mudstone	WRL-103-47	5.0	1.3	--	--	--	--	--	80.3	131.1	143.03	.001	--	.105

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)							Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F	Loss on ignition	Acid insoluble			all	Chem. U	
E-4	Mudstone	WRL-102-47	5.0	1.3	--	--	--	--	--	79.4	136.1	149.53	.001	--	.110
E-3	Mudstone	WRL-101-47	4.2	1.4	--	--	--	--	--	82.6	140.3	155.41	.001	--	.114
E-2	Mudstone	WRL-100-47	5.0	1.3	--	--	--	--	--	81.1	145.3	161.91	.001	--	.119
E-1	Mudstone	WRL-99-47	3.3	3.5	--	--	--	--	--	66.1	148.6	173.46	.003	--	.129

D member of Phosphoria formation, lot no. 1224

D-51	Mudstone	WRL-98-47	5.0	5.8	--	--	--	0.47	--	50.3	5.0	19.00	.003	--	.015
D-50	Mudstone	WRL-97-47	5.0	5.6	--	--	--	--	--	50.5	10.0	57.00	.003	--	.030
D-49	Mudstone	WRL-96-47	5.0	7.8	--	--	--	--	--	46.3	15.0	96.00	.003	--	.045
D-48	Limestone, argillaceous	WRL-95-47	1.3	6.8	--	--	--	--	--	40.8	16.3	104.84	.004	.001	.050
D-47	Limestone	WRL-94-47	4.1	1.8	--	--	--	--	--	19.2	20.4	112.22	.0005	.000	.052
D-46	Limestone, argillaceous	WRL-93-47	5.0	5.7	--	--	--	--	--	36.7	25.4	140.72	.004	.002	.072
D-45	Limestone, argillaceous	WRL-92-47	1.2	6.8	--	--	--	--	--	38.1	26.6	148.88	.005	.001	.078
D-44	Phosphate rock	WRL-91-47	2.5	26.8	--	--	--	2.72	--	12.3	29.1	215.88	.006	.003	.093
D-43	Mudstone, calcareous and phosphate rock	WRL-90-47	0.7	8.8	--	--	--	--	--	49.4	29.8	222.04	.003	.001	.095
D-42	Phosphate rock, calcareous	WRL-89-47	1.5	22.5	--	--	--	--	--	41.7	31.3	255.79	.005	.003	.103
D-41	Mudstone	WRL-88-47	3.0	6.9	--	--	--	--	--	56.9	34.3	276.49	.003	.001	.112
D-40	Phosphate rock, calcareous, argillaceous	WRL-87-47	2.3	16.7	--	--	--	--	--	23.7	36.6	314.90	.004	.002	.121
D-39	Phosphate rock and argillaceous limestone	WRL-86-47	1.1	21.7	--	--	--	--	--	13.5	37.7	338.77	.004	.002	.125
D-38	Limestone, phosphatic, argillaceous	WRL-85-47	0.6	12.9	--	--	--	--	--	32.3	38.3	346.51	.003	.001	.127
D-37	Dolomite, argillaceous	WRL-84-47	0.7	5.4	--	--	--	--	--	34.1	39.0	350.29	.002	.000	.129
D-36	Phosphate rock, argillaceous, calcareous	WRL-83-47	1.7	13.8	--	--	--	--	--	33.2	40.7	373.75	.005	.002	.137
D-35	Limestone, argillaceous	WRL-82-47	0.5	5.1	--	--	--	0.47	--	39.9	41.2	376.30	.002	.000	.138
D-34	Phosphate rock, argillaceous and limestone	WRL-81-47	2.9	14.9	--	--	--	1.55	--	33.7	44.1	419.51	.004	.001	.150
D-33	Limestone, argillaceous	WRL-80-47	2.9	4.9	--	--	--	--	--	26.3	47.0	433.72	.001	.000	.153
D-32	Mudstone, calcareous, phosphatic	WRL-79-47	1.3	8.5	--	--	--	--	--	41.9	48.3	444.77	.003	.000	.157
D-31	Limestone and phosphate rock	WRL-78-47	1.8	5.3	--	--	--	0.75	--	15.2	50.1	454.31	.001	.000	.158
D-30	Mudstone, calcareous, phosphatic	WRL-77-47	1.2	9.1	--	--	--	--	--	46.0	51.3	465.23	.003	.001	.162
D-29	Limestone	WRL-76-47	1.6	6.6	--	--	--	--	--	18.3	52.9	475.79	.002	.000	.165
D-28	Mudstone, calcareous, phosphatic	WRL-75-47	0.6	10.0	--	--	--	--	--	42.6	53.5	481.79	.002	.001	.166
D-27	Limestone	WRL-74-47	0.7	3.8	--	--	--	--	--	15.2	54.2	484.45	.001	.000	.167
D-26	Mudstone, calcareous, phosphatic	WRL-73-47	1.4	9.2	--	--	--	--	--	46.1	55.6	497.33	.003	.001	.171
D-25	Limestone, argillaceous	WRL-72-47	1.2	4.0	--	--	--	--	--	22.6	56.8	502.13	.002	.000	.174

D-24	Mudstone, calcareous	WRL- 71-47	0.6	7.1	--	--	--	--	--	50.6	57.4	506.39	.003	.000	.175
D-23	Phosphate rock, argillaceous, calcareous	WRL- 70-47	1.5	18.0	--	--	--	--	--	26.5	58.9	533.39	.004	.002	.181
D-22	Mudstone, phosphatic, calcareous	WRL- 69-47	0.7	12.2	--	--	--	--	--	41.2	59.6	541.93	.004	.001	.184
D-21	Mudstone, calcareous	WRL- 68-47	1.7	3.3	--	--	--	--	--	64.8	61.3	547.54	.003	.000	.189
D-20	Mudstone, phosphatic, calcareous	WRL- 67-47	0.3	12.7	--	--	--	--	--	40.0	61.6	551.35	.005	.002	.191
D-19	Mudstone	WRL- 66-47	0.8	3.4	--	--	--	--	--	69.7	62.4	554.07	.003	.000	.193
D-18	Mudstone and phosphate rock	WRL- 65-47	1.3	5.2	--	--	--	--	--	61.8	63.7	560.83	.004	.001	.198
D-17	Phosphate rock, argillaceous, calcareous	WRL- 64-47	0.5	15.3	--	--	--	1.29	--	36.0	64.2	568.48	.005	.002	.201
D-16	Mudstone	WRL- 63-47	2.5	2.3	--	--	--	--	--	72.3	66.7	574.23	.002	.000	.206
D-15	Mudstone, phosphatic	WRL- 62-47	0.5	14.5	--	--	--	--	--	41.7	67.2	581.48	.004	.001	.208
D-14	Mudstone, phosphatic	WRL- 61-47	0.9	8.1	--	--	--	--	--	53.9	68.1	588.77	.004	.001	.212
D-13	Phosphate rock	WRL- 60-47	0.9	24.0	--	--	--	2.74	--	18.3	69.0	610.37	.006	.002	.217
D-12	Mudstone, calcareous	WRL- 59-47	0.4	0.9	--	--	--	--	--	59.7	69.4	610.73	.003	.000	.218
D-11	Phosphate rock, argillaceous, calcareous	WRL- 58-47	0.4	15.0	--	--	--	1.70	--	36.4	69.8	616.73	.004	.002	.220
D-10	Mudstone	WRL- 57-47	1.4	1.9	--	--	--	--	--	75.9	71.2	619.39	.003	.000	.224
D- 9	Mudstone, calcareous, phosphatic	WRL- 56-47	1.7	10.5	--	--	--	--	--	44.9	72.9	637.24	.004	.001	.231
D- 8	Phosphate rock, argillaceous, calcareous	WRL- 55-47	1.5	15.7	--	--	--	--	--	30.6	74.4	660.79	.004	.002	.237
D- 7	Phosphate rock, calcareous, argillaceous	WRL- 54-47	1.3	16.0	--	--	--	--	--	34.3	75.7	681.59	.004	.002	.242
D- 6	Limestone	WRL- 53-47	1.2	0.9	--	--	--	--	--	17.9	76.9	682.67	.001	.000	.243
D- 5	Phosphate rock, argillaceous, calcareous	WRL- 52-47	1.3	14.6	--	--	--	--	--	32.7	78.2	701.65	.004	--	.248
D- 4	Phosphate rock, argillaceous, calcareous	WRL- 51-47	1.5	15.9	--	--	--	--	--	29.1	79.7	725.50	.005	.002	.256
D- 3	Mudstone, phosphatic, calcareous	WRL- 50-47	0.6	11.2	--	--	--	--	--	43.9	80.3	722.22	.004	.001	.258
D- 2	Limestone	WRL- 49-47	0.8	0.8	--	--	--	--	--	19.5	81.1	732.86	.001	.000	.259
D- 1	Mudstone, calcareous, phosphatic	WRL- 48-47	1.8	8.8	--	--	--	--	--	42.7	82.9	748.70	.004	.003	.266

C member of Phosphoria formation, lot no. 1224—top bed only

C- 1	Sandstone, phosphatic	WRL- 47-47	(1.7)	13.3	--	--	--	--	--	55.4	--	--	.005	.004	--
	WRL-47-47, lot no. 1224, logged as equivalent to upper 1.7 feet of WRL-198-47, lot no. 1225.														

C member of Phosphoria formation, lot no. 1225

C-36	Limestone, sandy	WRL-198-47	12.0	1.0	0.5	1.1	0.01	--	26.5	32.6	12.0	12.00	.0005	--	.006
C-35	Sandstone, calcareous	WRL-197-47	8.3	1.0	3.5	2.2	0.01	--	8.4	73.1	20.3	20.30	.0005	--	.010
C-34	Chert, calcareous	WRL-196-47	7.4	0.7	3.5	2.5	0.01	--	9.8	73.1	27.7	25.48	.0005	--	.014
C-33	Chert, calcareous	WRL-195-47	9.9	0.5	4.3	3.7	0.01	--	8.0	75.1	37.6	30.43	.0005	--	.019

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RESTRICTED



Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)								Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F	Loss on ignition	Acid insoluble				eU	Chem. U	
C-32	Chert and limestone	WRL-194-47	11.0	0.5	1.3	5.1	0.01	--	12.1	63.2		48.6	35.93	.0005	--	.024
C-31	Chert and limestone	WRL-193-47	7.2	0.3	3.2	2.6	0.01	--	13.8	62.3		55.8	38.09	.001	--	.032
C-30	Mudstone, calcareous	WRL-192-47	5.0	1.1	6.2	2.4	0.01	--	14.1	59.0		60.8	43.59	.002	--	.042
C-29	Limestone, cherty	WRL-191-47	4.4	0.5	0.3	3.5	0.01	--	17.6	52.9		65.2	45.79	.0005	--	.044
C-28	Limestone, sandy	WRL-190-47	4.3	0.4	4.1	1.7	0.01	--	22.8	43.2		69.5	47.51	.0005	--	.046
C-27	Sandstone, calcareous	WRL-189-47	3.1	0.6	1.1	2.7	0.01	--	14.5	62.7		72.6	49.37	.0005	--	.047
C-26	Limestone, sandy	WRL-188-47	3.2	0.7	0.5	1.1	0.01	--	27.4	36.0		75.8	51.61	.0005	--	.049
C-25	Sandstone and limestone	WRL-187-47	7.8	0.6	0.6	1.6	0.01	--	19.9	51.3		83.6	56.29	.0005	--	.053
C-24	Limestone, sandy	WRL-186-47	2.5	0.8	0.6	1.7	0.01	--	23.2	44.6		86.1	58.29	.0005	--	.054
C-23	Limestone, sandy	WRL-185-47	2.7	0.6	0.8	1.2	0.01	--	35.0	20.5		88.8	59.91	.001	--	.057
C-22	Sandstone, calcareous	WRL-184-47	5.8	1.8	0.2	1.3	0.01	--	16.1	58.6		94.6	70.35	.0005	--	.060
C-21	Limestone, sandy	WRL-183-47	7.3	0.8	0.7	1.6	0.01	--	26.3	37.0		101.9	76.19	.0005	--	.063
C-20	Limestone, cherty	WRL-182-47	7.8	0.3	0.5	2.6	0.01	--	22.2	43.1		109.7	78.53	.0005	--	.067
C-19	Chert, calcareous	WRL-181-47	3.7	0.3	1.3	3.2	0.02	--	13.5	63.8		113.4	79.64	.0005	--	.069
C-18	Limestone, sandy	WRL-180-47	1.4	0.8	0.6	2.04	0.02	--	21.5	47.4		114.8	80.76	.0005	--	.070
C-17	Limestone, sandy	WRL-179-47	4.5	0.7	0.6	1.6	0.02	--	25.4	40.6		119.3	83.91	.0005	--	.072
C-16	Sandstone and limestone	WRL-178-47	12.3	0.7	0.2	1.9	0.02	--	18.5	55.4		131.6	92.52	.0005	--	.078
C-15	Limestone, sandy	WRL-177-47	2.4	0.6	0.9	1.2	0.01	--	34.5	21.3		134.0	93.96	.001	--	.081
C-14	Sandstone, calcareous	WRL-176-47	5.4	1.5	0.4	0.9	0.02	--	14.7	62.2		139.4	102.06	.0005	--	.083
C-13	Limestone	WRL-175-47	1.3	0.2	0.5	1.1	0.01	--	40.7	9.1		140.7	102.32	.0005	--	.084
C-12	Limestone	WRL-174-47	6.2	1.9	0.3	0.7	0.01	--	37.5	10.4		146.9	114.10	.001	--	.090
C-11	Sandstone, calcareous	WRL-173-47	9.5	1.4	0.6	1.7	0.01	--	32.6	67.2		156.4	127.40	.001	--	--
C-10	Chert, sandy	WRL-172-47	4.2	0.5	0.3	2.9	0.01	--	0.3	94.3		160.6	129.50	.0005	--	.002*
C-9	Chert	WRL-171-47	2.0	0.3	1.0	2.9	0.01	--	1.0	92.8		162.6	130.10	.0005	--	.003
C-8	Chert	WRL-170-47	3.2	0.4	1.3	4.7	0.02	--	2.2	88.1		165.8	131.38	.0005	--	.005
C-7	Chert	WRL-169-47	5.0	0.3	1.1	2.9	0.01	--	2.6	89.4		170.8	132.88	.000	--	.005
C-6	Chert	WRL-168-47	5.0	0.4	1.6	4.4	0.02	--	3.6	85.9		175.8	134.88	.0005	--	.007
C-5	Chert	WRL-167-47	5.0	0.5	1.9	4.9	0.01	--	5.7	79.7		180.8	137.38	.0005	--	.010
C-4	Chert	WRL-166-47	5.0	0.4	2.1	4.8	0.01	--	6.9	78.2		185.8	139.38	.0005	--	.012
C-3	Chert	WRL-165-47	5.0	0.5	1.7	4.7	0.02	--	7.2	77.1		190.8	141.88	.0005	--	.015
C-2	Chert, calcareous	WRL-164-47	5.0	0.4	1.8	4.0	0.01	--	13.9	63.4		195.8	143.88	.0005	--	.017
C-1	Chert	WRL-163-47	4.0	0.5	2.0	3.2	0.02	--	2.2	89.7		199.8	145.88	.0005	--	.019**
B member of Phosphoria formation, lot no. 1225																
B-30	Mudstone and chert	WRL-162-47	1.4	1.0	4.7	3.1	0.01	--	8.2	79.9		1.4	1.40	.001	--	.001
B-29	Mudstone	WRL-161-47	1.5	1.4	6.4	2.7	0.03	--	9.7	74.3		2.9	3.50	.002	--	.004
B-28	Limestone, argillaceous	WRL-160-47	0.6	0.4	1.2	0.8	0.02	--	35.1	22.8		3.5	3.74	.0005	--	.005

\* Cumulative data incomplete due to missing information. Computations start from zero after interruption.  
 \*\* Note incompleteness of cumulative data.

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B-27	Limestone, argillaceous and phosphate rock	WRL-159-47	0.8	7.5	2.2	1.5	0.02	--	24.9	27.3	4.3	9.74	.002	--	.006
B-26	Mudstone	WRL-158-47	1.8	3.2	6.8	3.1	0.04	--	9.6	68.7	6.1	15.50	.002	--	.010
B-25	Mudstone, phosphatic, calcareous	WRL-157-47	2.3	11.7	1.8	1.7	0.02	--	11.4	43.0	8.4	42.41	.004	--	.019
B-24	Chert and mudstone	WRL-156-47	5.4	0.9	2.7	3.5	0.02	--	3.5	83.7	13.8	47.27	.001	--	.025
B-23	Mudstone, cherty	WRL-155-47	3.2	0.3	5.8	3.9	0.02	--	5.0	79.0	17.0	48.23	.002	--	.031
B-22	Mudstone, cherty	WRL-154-47	2.8	0.2	6.8	3.5	0.03	--	3.4	86.6	19.8	48.79	.002	--	.037
B-21	Chert	WRL-153-47	3.3	2.9	2.9	3.6	0.03	--	8.4	70.7	23.1	58.36	.002	--	.043
B-20	Chert, calcareous and mudstone	WRL-152-47	2.3	2.3	1.7	3.4	0.03	--	15.0	56.3	25.4	63.65	.002	--	.048
B-19	Phosphate rock, calcareous, argillaceous	WRL-151-47 <sup>1</sup>	1.0	18.1	3.4	1.9	0.06	--	11.6	25.6	26.4	81.75	.010	.008	.058
B-18	Mudstone	WRL-150-47	1.3	1.5	7.9	3.6	0.47	--	13.1	66.1	27.7	83.70	.004	--	.063
B-17	Limestone, argillaceous	WRL-149-47	0.8	0.3	5.8	3.4	0.08	--	19.9	48.0	28.5	88.94	.002	--	.065
B-16	Mudstone, calcareous, phosphatic	WRL-148-47	1.5	9.5	7.2	2.9	0.12	--	10.6	50.0	30.0	98.19	.007	.005	.075
B-15	Mudstone, calcareous	WRL-147-47	2.4	2.0	6.2	2.7	0.03	--	19.4	45.4	32.4	102.99	.002	--	.080
B-14	Mudstone, phosphatic	WRL-146-47	0.5	14.6	5.3	2.2	0.03	--	10.0	39.4	32.9	110.29	.005	.004	.082
B-13	Mudstone, calcareous	WRL-145-47	1.7	1.4	6.9	2.8	0.03	--	16.1	54.0	34.6	112.67	.008	.001	.096
B-12	Limestone, argillaceous	WRL-144-47	3.3	5.8	6.0	2.6	0.04	--	26.0	35.7	37.9	131.81	.004	--	.109
B-11	Phosphate rock, calcareous	WRL-143-47	2.6	19.8	2.3	1.4	0.14	--	20.8	12.0	40.5	183.29	.012	.010	.140
B-10	Limestone, argillaceous	WRL-142-47	1.3	4.8	5.4	2.1	0.09	--	33.8	27.8	41.8	189.53	.003	--	.144
B-9	Limestone, argillaceous	WRL-141-47	1.0	3.6	5.2	2.3	0.1	--	37.3	27.3	42.8	193.13	.003	--	.147
B-8	Limestone, argillaceous	WRL-140-47	1.5	3.3	5.2	2.2	0.07	--	36.3	27.9	44.3	198.08	.003	--	.152
B-7	Limestone, phosphatic, argillaceous	WRL-139-47	1.2	8.0	3.8	1.6	0.1	--	31.0	20.8	45.5	207.68	.005	.004	.158
B-6	Mudstone, calcareous and calcareous phosphate rock	WRL-138-47	1.8	16.6	3.1	1.9	0.11	--	24.7	15.2	47.3	237.56	.008	.006	.172
B-5	Phosphate rock, calcareous	WRL-137-47	1.2	22.1	2.4	1.0	0.07	--	12.5	15.2	48.5	264.08	.009	.007	.183
B-4	Phosphate rock, calcareous and calcareous mudstone	WRL-136-47	1.5	20.5	2.3	1.2	0.09	--	18.3	14.2	50.0	294.83	.009	.007	.196
B-3	Limestone, argillaceous	WRL-135-47	1.2	3.3	4.9	1.8	0.11	--	23.7	41.1	51.2	298.79	.004	--	.201
B-2	Phosphate rock	WRL-134-47	1.2	16.8	3.6	1.9	0.2	--	22.1	19.3	52.4	318.95	.007	.006	.210
B-1	Phosphate rock	WRL-133-47	2.0	29.4	0.8	0.8	0.008	3.16	6.4	8.8	54.4	377.75	.009	.007	.228

A member of Phosphoria formation, lot nos. 1226 and 1227

Lot no. 1226															
A-53	Limestone	WRL-132-47	5.0	0.2	--	--	--	--	--	4.9	5.0	1.00	.000	--	.000
A-52	Mudstone, calcareous	WRL-131-47	2.3	0.2	--	--	--	--	--	60.7	7.3	1.46	.002	--	.005
A-51	Limestone	WRL-130-47	4.7	0.2	--	--	--	--	--	17.9	12.0	2.40	.0005	--	.007
A-50	Limestone	WRL-129-47	4.9	1.2	--	--	--	--	--	3.3	16.9	8.28	.0005	--	.009
A-49	Mudstone, calcareous	WRL-128-47	4.8	0.2	--	--	--	--	--	63.3	21.7	9.24	.002	--	.019
A-48	Mudstone, calcareous	WRL-127-47	5.0	0.3	--	--	--	--	--	62.6	26.7	10.74	.002	--	.029
A-47	Mudstone, calcareous	WRL-126-47	5.0	0.1	--	--	--	--	--	64.8	31.7	11.24	.002	--	.039
A-46	Mudstone, calcareous	WRL-125-47	5.0	1.2	--	--	--	--	--	72.9	36.7	17.24	.002	--	.049

<sup>1</sup> See additional analyses at end of table.

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Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)							Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	V <sub>2</sub> O <sub>5</sub>	F	Loss on ignition	Acid insoluble			eU	Chem. U	
A-45	Mudstone, calcareous	WRL-124-47	5.0	0.1	--	--	--	--	--	72.0	41.7	17.74	.002	--	.059
A-44	Mudstone, calcareous	WRL-123-47	2.3	0.1	--	--	--	--	--	71.4	44.0	17.97	.002	--	.064
A-43	Mudstone, calcareous	WRL-122-47	5.0	1.3	--	--	--	--	--	70.8	49.0	24.47	.002	--	.074
A-42	Mudstone, calcareous	WRL-121-47	5.0	1.3	--	--	--	--	--	72.1	54.0	30.97	.002	--	.084
A-41	Mudstone, calcareous	WRL-120-47	5.0	1.3	--	--	--	--	--	71.4	59.0	37.47	.002	--	.094
A-40	Mudstone, calcareous	WRL-119-47	5.0	0.1	--	--	--	--	--	70.9	64.0	37.97	.001	--	.099
A-39	Sandstone, calcareous	WRL-118-47	2.5	0.1	--	--	--	--	--	77.9	66.5	38.22	.001	--	.101
A-38	Mudstone, calcareous	WRL-117-47	3.7	0.1	--	--	--	--	--	78.2	70.2	38.59	.002	--	.109
A-37	Mudstone, calcareous	WRL-116-47	5.0	0.1	--	--	--	--	--	68.9	75.2	39.09	.002	--	.119
A-36	Mudstone, calcareous	WRL-115-47	5.0	1.3	--	--	--	--	--	65.5	80.2	45.59	.002	--	.129
A-35	Mudstone, calcareous	WRL-114-47	5.0	0.1	--	--	--	--	--	65.4	85.2	46.09	.002	--	.139
A-34	Mudstone, calcareous	WRL-113-47	5.0	0.1	--	--	--	--	--	65.6	90.2	46.59	.001	--	.144
A-33	Mudstone, calcareous	WRL-112-47	5.0	1.4	--	--	--	--	--	65.0	95.2	53.59	.002	--	.154
A-32	Mudstone, calcareous	WRL-111-47	5.0	1.2	--	--	--	--	--	58.6	100.2	59.59	.002	--	.164
A-31	Mudstone, calcareous and calcareous sandstone	WRL-110-47	4.5	1.2	--	--	--	--	--	69.3	104.7	64.99	.001	--	.168
A-30	Mudstone, calcareous	WRL-109-47	2.8	0.2	--	--	--	--	--	65.2	107.5	65.55	.002	--	.174
A-29	Sandstone, calcareous and mudstone	WRL-108-47	3.6	0.3	--	--	--	--	--	70.2	111.1	66.63	.001	--	.177
A-28	Limestone, cherty	WRL-250-47	2.3	0.5	--	--	--	--	--	48.1	113.4	67.78	.001	--	.180
A-27	Limestone and sandstone	WRL-249-47	2.4	0.3	--	--	--	--	--	48.4	115.8	68.50	.001	--	.182
A-26	Phosphate rock	WRL-248-47	1.0	31.4	--	--	--	--	--	12.0	116.8	99.90	.008	.007	.190
A-25	Limestone, cherty	WRL-247-47	2.6	0.5	--	--	--	--	--	34.1	119.4	101.20	.001	--	.193
A-24	Limestone and chert	WRL-246-47	3.5	0.3	--	--	--	--	--	29.1	122.9	102.25	.001	--	.196
A-23	Limestone	WRL-245-47	1.8	0.1	--	--	--	--	--	9.9	124.7	102.43	.0005	--	.197
	Lot no. 1227														
A-22	Limestone, sandy	WRL-244-47	5.6	0.0	--	--	--	--	--	48.4	130.3	102.43	.0005	--	.200
A-21	Limestone and sandstone, calcareous	WRL-243-47	19.2	0.1	--	--	--	--	--	68.3	149.5	104.35	.001	--	.219
A-20	Limestone, sandy	WRL-242-47	7.7	0.1	--	--	--	--	--	28.0	157.2	105.12	.001	--	.227
A-19	Limestone	WRL-241-47	25.6	1.3	--	--	--	--	--	19.9	182.8	138.40	.0005	--	.239
A-18	Chert and limestone	WRL-240-47	5.8	0.4	--	--	--	--	--	55.1	188.6	140.72	.001	--	.245
A-17	Limestone	WRL-239-47	12.4	0.2	--	--	--	--	--	11.3	201.0	143.20	.001	--	.258
A-16	Limestone, argillaceous	WRL-238-47	4.2	0.4	--	--	--	--	--	25.6	205.2	144.88	.002	--	.266
A-15	Limestone, argillaceous	WRL-237-47	4.0	0.4	--	--	--	--	--	40.6	209.2	146.48	.004	--	.282
A-14	Mudstone	WRL-236-47	2.3	0.5	--	--	--	--	--	76.3	211.5	147.63	.003	--	.289
A-13	Sandstone	WRL-235-47	17.8	0.2	--	--	--	--	--	89.2	229.3	151.19	.0005	--	.298
A-12	Limestone, sandy, cherty	WRL-234-47	11.0	0.3	--	--	--	--	--	32.2	240.3	154.49	.0005	--	.303
A-11	Sandstone, calcareous	WRL-233-47	7.5	0.1	--	--	--	--	--	76.8	247.8	155.24	.0005	--	.307
A-10	Mudstone, calcareous	WRL-232-47	2.3	0.4	--	--	--	--	--	71.6	250.1	156.16	.0005	--	.308

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A- 9	Limestone, argillaceous	WRL-231-47	17.1	0.2	--	--	--	--	--	41.1	267.2	159.58	.0005	--	.317
A- 8	Chert and limestone float, bedrock not exposed	--	15.8	--	--	--	--	--	--	--	283.0	--	--	--	--
A- 7	Chert, calcareous, sandy	WRL-229-47	5.4	0.1	--	--	--	--	--	66.7	288.4	0.54*	.0005	--	.003*
A- 6	Chert and limestone	WRL-228-47	5.4	1.3	--	--	--	--	--	54.8	293.8	7.56	.0005	--	.005
A- 5	Chert, calcareous, and limestone	WRL-227-47	10.7	1.3	--	--	--	--	--	58.7	304.5	21.47	.001	--	.016
A- 4	Sandstone, calcareous	WRL-226-47	6.8	1.3	--	--	--	--	--	75.6	311.3	30.31	.001	--	.023
A- 3	Limestone, cherty, sandy	WRL-225-47	6.5	1.4	--	--	--	--	--	25.7	317.8	39.41	.0005	--	.026
A- 2	Limestone	WRL-224-47	16.1	0.1	--	--	--	--	--	7.0	333.9	41.02	.0005	--	.034
A- 1	Limestone	WRL-223-47	13.3	1.2	--	--	--	--	--	6.1	347.2	56.98**	.0005	--	.041**

Quadrant formation—not measured

\* Cumulative data incomplete due to missing information. Computations start from zero after interruption.

\*\* Note incompleteness of cumulative data.

Additional analyses of sample WRL-150-47<sup>2</sup>

Bed no.	Sample no.	P <sub>2</sub> O <sub>5</sub>	V <sub>2</sub> O <sub>5</sub>	F	SiO <sub>2</sub>	TiO <sub>2</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	MnO
B-18	WRL-150-47	2.81	0.56	0.31	60.60	0.48	4.02	2.34	0.17	3.15	0.028
		Ni	Cr <sub>2</sub> O <sub>3</sub>	Co	Zn	Cu	Pb	Ag	MoO <sub>3</sub>	W	Organic matter
		0.022	0.02	0.004	0.003	0.011	0.006	0.0001	0.006	<0.005	6.66 <sup>3</sup>

<sup>2</sup> Analyses made by the U. S. Geological Survey, Geochemistry and Petrology Branch.

<sup>3</sup> CO<sub>2</sub> and S reported present.



## WADHAM SPRINGS, MONTANA. LOT NOS. 1246 and 1247.

Phosphoria formation sampled in bulldozer trenches near Wadham Springs on southeast limb of anticline. Upper part of formation, lot no. 1246, sampled in north trench, SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 22; and lower part of formation, lot no. 1247, in south trench, SW $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 28, T. 13 S., R. 7 W., Beaverhead County, Montana. Beds strike N. 30° E. and dip 70-80° SE. Section measured by D. A. Bostwick, E. R. Cressman, and L. A. Thomas and sampled by Bostwick, Cressman, Thomas, and W. H. Wilson in August 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation										
Td-1	Mudstone	ERC-157	--	1.3	83.1	--	--	.001	--	--
E member of Phosphoria formation, lot no. 1247										
E-12	Mudstone and chert	ERC-156	3.6	1.4	78.5	3.6	5.04	.0005	--	.002
E-11	Siltstone and sandstone	ERC-155	5.8	1.3	78.2	9.4	12.58	.001	--	.008
E-10	Mudstone, chert, and sandstone	DAB-154	9.4	1.4	88.1	18.8	25.74	.0005	--	.012
E-9	Mudstone and chert	DAB-153	11.2	1.4	89.1	30.0	41.42	.0005	--	.018
E-8	Sandstone and chert	DAB-152	2.1	1.3	86.3	32.1	44.15	.0005	--	.019
E-7	Mudstone and chert	ERC-151	14.5	1.4	89.7	46.6	64.45	.0005	--	.026
E-6	Chert	ERC-150	8.1	1.7	90.5	54.7	78.22	.0005	--	.030
E-5	Mudstone and chert	ERC-149	12.3	1.1	89.9	67.0	91.75	.0005	--	.036
E-4	Mudstone and chert; fos. col. no. 48-KPM-69 <sup>1</sup>	DAB-148	9.3	1.4	92.0	76.3	104.77	.0005	--	.041
E-3	Mudstone and chert	DAB-147	18.0	1.0	92.5	94.3	122.77	.0005	--	.050
E-2	Mudstone and chert; fos. col. no. 48-KPM-69	DAB-146	14.8	1.1	93.1	109.1	139.05	.0005	--	.057
E-1	Chert, phosphatic	ERC-145	0.8	16.9	53.2	109.9	152.57	.005	.005	.061
D member of Phosphoria formation, lot no. 1247										
D-23	Mudstone, phosphatic	ERC-144	1.5	17.0	51.2	1.5	25.50	.003	--	.005
D-22	Phosphate rock, argillaceous	ERC-143	2.05	28.5	20.2	3.55	83.92	.009	.007	.023
D-21	Phosphate rock, argillaceous	DAB-142	0.5	21.6	31.7	4.05	94.72	.006	.006	.026
D-20	Mudstone, phosphatic	DAB-141	0.8	9.9	59.6	4.85	102.64	.005	.004	.030
D-19	Mudstone; fos. col. no. 48-KPM-68	DAB-140	3.3	3.9	75.9	8.15	115.51	.003	--	.040
D-18	Mudstone and phosphate rock	ERC-139	3.5	14.2	48.0	11.65	165.21	.006	.006	.061
D-17	Mudstone	ERC-138	1.2	3.6	72.9	12.85	169.53	.002	--	.063
D-16	Mudstone and phosphate rock	ERC-137	0.7	10.5	52.0	13.55	176.88	.005	.004	.067
D-15	Mudstone	DAB-136	1.8	4.4	71.3	15.35	181.80	.003	--	.072
D-14	Mudstone, phosphatic	DAB-135	1.5	11.4	53.3	16.85	201.90	.005	.005	.080
D-13	Phosphate rock, argillaceous	DAB-134	0.6	17.9	44.3	17.45	212.64	.006	.006	.083
D-12	Mudstone, phosphatic	DAB-133	1.0	9.7	55.8	18.45	222.34	.005	.005	.088

D-11	Mudstone and phosphate rock	DAB-132	0.8	14.3	46.1	19.25	233.78	.007	.007	.094
D-10	Mudstone	DAB-131	1.0	6.2	66.0	20.25	239.98	.003	--	.097
D- 9	Mudstone	ERC-130	1.9	6.4	65.8	22.15	252.14	.002	--	.101
D- 8	Mudstone, phosphatic	ERC-129	1.1	8.5	52.5	23.25	261.49	.005	.003	.106
D- 7	Mudstone	ERC-128	1.2	6.3	63.0	24.45	269.05	.004	--	.111
D- 6	Mudstone and phosphate rock	ERC-127	3.7	17.1	40.3	28.15	332.32	.005	.005	.129
D- 5	Mudstone	ERC-126	0.8	5.3	75.7	28.95	336.56	.002	--	.131
D- 4	Mudstone, phosphatic	ERC-125	2.3	14.3	45.1	31.25	369.45	.006	.006	.145
D- 3	Phosphate rock, argillaceous	DAB-124	0.8	16.2	41.3	32.05	382.41	.003	--	.147
D- 2	Mudstone and phosphate rock	DAB-123	3.6	9.7	59.0	35.65	417.33	.005	.005	.165
D- 1	Mudstone and phosphate rock	DAB-122	2.3	7.2	61.7	37.95	433.89	.005	.005	.178

29 feet below D-1 not exposed though trenched by bulldozer and hand to depth of 24 feet. Interval probably chiefly D member.

C member of Phosphoria formation, lot nos. 1246 and 1247

Lot no. 1247										
C-18	Limestone; fos. col. no. 48-KPM-67	ERC-121	21.8	0.7	11.3	21.8	15.26	.008	.002	.174
C-17	Limestone; fos. col. no. 48-KPM-66	DAB-120	22.5	1.2	16.5	44.3	42.26	.001	--	.197
C-16	Limestone; fos. col. no. 48-KPM-65	DAB-119	15.0	0.8	11.3	59.3	54.26	.001	--	.212
C-15	Limestone; fos. col. no. 48-KPM-64	DAB-118	18.4	0.6	16.0	77.7	65.30	.0005	--	.221
C-14	Mudstone, calcareous	ERC-117	17.7	0.6	53.3	95.4	75.92	.001	--	.239
C-13	Mudstone, calcareous	ERC-116	20.3	0.4	73.4	115.7	84.04	.001	--	.259
C-12	Mudstone, calcareous	ERC-115	12.2	0.7	57.0	127.9	92.58	.001	--	.271
C-11	Limestone	DAB-114	2.6	0.3	18.9	130.5	93.36	.0005	--	.273
C-10	Limestone; fos. col. no. 48-KPM-63	DAB-113	19.8	0.3	6.8	150.3	99.30	.0005	--	.282
C- 9	Limestone; fos. col. no. 48-KPM-62	DAB-112	13.3	0.3	5.8	163.6	103.29	.0005	--	.289
C- 8	Limestone	DAB-111	14.9	0.3	12.6	178.5	107.76	.0005	--	.297
C- 7	Limestone	DAB-110	13.6	0.2	12.5	192.1	110.48	.0005	--	.303
C- 6	Limestone	DAB-109	7.3	0.2	5.9	199.4	111.94	.0005	--	.307
C- 5	Limestone, argillaceous	DAB-108	8.2	0.3	21.3	207.6	114.40	.0005	--	.311
C- 4	Sandstone, calcareous	DAB-107	1.2	1.3	56.5	208.8	115.96	.001	--	.312
C- 3	Chert	DAB-106	14.8	0.2	87.7	223.6	118.92	.0005	--	.320
Lot no. 1246										
C- 2	Chert, sandstone and mudstone	LAT-105	17.7	0.7	93.9	241.3	131.31	.0005	--	.329
C- 1	Mudstone and chert	DAB-104	13.6	0.65	93.3	254.9	140.15	.001	--	.342

B member of Phosphoria formation, lot no. 1246

B- 8	Mudstone; fos. col. nos. 48-KPM-61 and 48-KPM-60	DAB-103	13.2	2.2	87.2	13.2	29.04	.002	--	.026
--	Mudstone, phosphatic	LAT-264	(1.3)	10.7	70.0	--	--	.002	--	--

LAT-264 represents upper 1.3 feet of DAB-103.

<sup>1</sup> Fossil collection by K. P. McLaughlin, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
B- 7	Chert and mudstone	DAB-102	4.6	0.35	95.3	17.8	30.65	.0005	--	.029
B- 6	Mudstone and chert	ERC-101	5.7	0.60	93.3	23.5	34.07	.001	--	.034
B- 5	Mudstone, cherty	ERC-100	14.3	0.3	94.0	37.8	38.36	.0005	--	.042
B- 4	Phosphate rock, sandy	ERC- 99	0.9	26.1	29.5	38.7	61.85	.009	.007	.050
B- 3	Mudstone; fos. col. no. 48-KPM-59	LAT- 98	8.2	4.6	74.0	46.9	99.57	.004	--	.082
B- 2	Phosphate rock, argillaceous	LAT-263	0.8	26.3	22.4	47.7	120.61	.011	.013	.091
B- 1	Phosphate rock, argillaceous	LAT-262	4.3	23.2	23.6	52.0	220.37	.013	.013	.147
A member of Phosphoria formation, lot no. 1246										
A-15	Mudstone, calcareous	LAT- 96	6.8	0.6	76.0	6.8	4.08	.001	--	.007
A-14	Mudstone and limestone	ERC- 95	3.8	0.6	51.6	10.6	6.36	.002	--	.014
A-13	Limestone	ERC- 94	2.0	0.2	6.5	12.6	6.76	.0005	--	.015
A-12	Mudstone, calcareous	ERC- 93	3.2	0.4	67.6	15.8	8.04	.001	--	.019
A-11	Limestone	DAB- 92	3.3	0.2	10.2	19.1	8.70	.0005	--	.020
A-10	Mudstone, calcareous	DAB- 91	1.9	0.25	70.1	21.0	9.18	.002	--	.024
A- 9	Limestone; fos. col. no. 48-KPM-58	DAB- 90	5.4	0.3	6.7	26.4	10.80	.0005	--	.027
A- 8	Mudstone, calcareous	LAT- 89	12.7	0.1	50.0	39.1	12.06	.001	--	.039
A- 7	Mudstone, calcareous	LAT- 88	12.7	0.1	57.0	51.8	13.34	.001	--	.052
A- 6	Mudstone, calcareous	LAT- 87	11.6	0.25	66.6	53.4	16.24	.002	--	.075
A- 5	Mudstone, calcareous, cherty	ERC- 86	9.4	0.4	72.8	72.8	20.00	.001	--	.085
A- 4	Mudstone and limestone	ERC- 85	8.1	0.4	32.4	80.9	23.24	.0005	--	.089
A- 3	Mudstone and chert; fos. col. no. 48-KPM-57	ERC- 84	11.6	0.3	56.6	92.5	26.72	.0005	--	.095
A- 2	Limestone	DAB- 83	18.2	0.2	4.6	110.7	30.36	.0005	--	.104
A- 1	Mudstone, calcareous, and sandstone	DAB- 82	12.4	0.5	85.5	123.1	36.56	.001	--	.116
Quadrant formation										
Cq-1	Sandstone	DAB- 81	18.0	0.2	97.6	--	--	.000	--	--

## CENTENNIAL RANGE TRENCH NO. 4, MONTANA. LOT NO. 1251.

B member of Phosphoria formation sampled in hand trench at Centennial Range locality no. 4 along south side of east fork of Odell Creek, near E½ corner sec. 6, T. 15 S., R. 1 W., Beaverhead County, Montana, on southward-dipping homocline. Beds strike N. 70° W. and dip 10° S. Section measured by F. S. Honkala and sampled by O. A. Payne in August 1948. Samples analyzed for  $P_2O_5$ , F, and acid insoluble by U. S. Bureau of Mines Laboratory, Albany, Oregon, and for other constituents by Trace Elements Section Laboratory, U. S. Geological Survey, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)						Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	F	Loss on ignition	Acid insoluble			eU	Chem. U	
C member of Phosphoria formation—not measured														
B member of Phosphoria formation														
B-1	Phosphate rock	FSH-261	6.2	31.3	0.97	0.81	3.16	3.90	10.9	6.2	--	.012	.010	--
A member of Phosphoria formation—not measured														



ODELL CREEK, MONTANA. LOT NO. 1252.

Upper part of Phosphoria formation sampled and lower part of Dinwoody formation measured in hand trench on west side of Odell Creek, SE $\frac{1}{4}$  sec. 1, T. 15 S., R. 2 W., Beaverhead County, Montana, on southward-dipping homocline. Beds strike N. 82° E. and dip 30° S. Section measured by F. S. Honkala and O. A. Payne and sampled by Payne and J. A. Kelleher in 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU by the U. S. Geological Survey, Geochemistry and Petrology Branch.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent) eU	Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble				
Lower part of Dinwoody formation									
Td-30	Limestone	--	2.1	--	--	2.1	--	--	--
Td-29	Limestone	--	2.8	--	--	4.9	--	--	--
Td-28	Mudstone	--	2.6	--	--	7.5	--	--	--
Td-27	Limestone	--	2.9	--	--	10.4	--	--	--
Td-26	Limestone and dolomite	--	3.6	--	--	14.0	--	--	--
Td-25	Limestone	--	5.0	--	--	19.0	--	--	--
Td-24	Mudstone, calcareous	--	4.9	--	--	23.9	--	--	--
Td-23	Limestone and calcareous mudstone	--	2.7	--	--	26.6	--	--	--
Td-22	Dolomite	--	4.5	--	--	31.1	--	--	--
Td-21	Dolomite and calcareous mudstone	--	5.0	--	--	36.1	--	--	--
Td-20	Dolomite	--	3.3	--	--	39.4	--	--	--
Td-19	Dolomite	--	5.0	--	--	44.4	--	--	--
Td-18	Dolomite	--	2.2	--	--	46.6	--	--	--
Td-17	Dolomite and calcareous mudstone	--	2.3	--	--	48.9	--	--	--
Td-16	Dolomite	--	3.3	--	--	52.2	--	--	--
Td-15	Limestone	--	1.8	--	--	54.0	--	--	--
Td-14	Dolomite and limestone	--	3.4	--	--	57.4	--	--	--
Td-13	Mudstone and dolomite	--	3.2	--	--	60.6	--	--	--
Td-12	Dolomite and mudstone	--	0.5	--	--	61.1	--	--	--
Td-11	Dolomite	--	1.3	--	--	62.4	--	--	--
Td-10	Dolomite	--	2.0	--	--	64.4	--	--	--
Td-9	Dolomite	--	1.7	--	--	66.1	--	--	--
Td-8	Dolomite and mudstone	--	3.0	--	--	69.1	--	--	--
Td-7	Dolomite	--	1.4	--	--	70.5	--	--	--
Td-6	Dolomite	--	3.1	--	--	73.6	--	--	--
Td-5	Dolomite and mudstone	--	1.6	--	--	75.2	--	--	--
Td-4	Mudstone, calcareous	--	2.1	--	--	77.3	--	--	--
Td-3	Mudstone	--	0.3	--	--	78.1	--	--	--
Td-2	Mudstone	--	2.2	--	--	80.3	--	--	--
Td-1	Mudstone, calcareous and dolomite	FSH-417	2.4	0.6	17.6	82.7	--	.0005	--

E member of Phosphoria formation—upper part only

E-16	Mudstone, calcareous	FSH-416	2.6	0.4	57.1	2.6	1.04	.002	.005
E-15	Mudstone, calcareous and limestone	FSH-415	1.8	0.3	49.2	4.4	1.58	.002	.009
E-14	Limestone, argillaceous	FSH-414	1.5	0.4	45.0	5.9	2.38	.002	.012
E-13	Limestone	FSH-413	0.8	0.7	15.6	6.7	2.74	.0005	.012
E-12	Mudstone, calcareous	FSH-412	0.2	0.5	50.6	6.9	2.84	.002	.013
E-11	Limestone	FSH-411	1.0	0.7	11.6	7.9	3.54	.005	.013
E-10	Limestone, argillaceous	FSH-410	0.3	0.75	29.6	8.2	3.76	.001	.013
E-9	Limestone, argillaceous	FSH-409	1.3	0.4	38.5	9.5	4.28	.0005	.014
E-8	Mudstone, calcareous	FSH-408	0.6	0.2	70.0	10.1	4.40	.002	.015
E-7	Mudstone	FSH-407	0.9	0.9	78.9	11.0	5.21	.001	.016
E-6	Chert	FSH-406	1.4	1.8	86.7	12.4	7.73	.0005	.017
E-5	Mudstone	OAP-405	4.5	1.5	84.0	16.9	14.48	.001	.021
E-4	Chert	OAP-404	1.5	1.05	90.6	18.4	16.06	.0005	.022
E-3	Mudstone and sandstone	OAP-403	0.7	1.3	89.3	19.1	16.97	.0005	.022
E-2	Sandstone	OAP-402	0.7	4.6	82.9	19.8	20.19	.0005	.023
E-1	Chert	OAP-401	2.6	0.4	94.8	22.4	21.23	.0005	.024

## CENTENNIAL RANGE TRENCH NO. 1, MONTANA. LOT NO. 1253.

D, E, and part of C members of Phosphoria formation sampled in hand trench at Centennial Range locality no. 1 near crest of range, NW corner sec. 33, T. 14 S., R. 1 W., Beaverhead County, Montana, on southward-dipping homocline. Beds strike east and dip 20° S. Section measured by F. S. Honkala and O. A. Payne and sampled by J. A. Kelleher in July 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch.

Bed no.	Rock description.	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation										
Td-1	Mudstone	OAP-496	0.7	0.8	79.7	--	--	.0005	.0005	--
E member of Phosphoria formation										
E-21	Mudstone, calcareous	OAP-495	2.8	1.3	58.8	2.8	3.64	.001	.0005	.002
E-20	Mudstone, calcareous	OAP-494	2.5	1.4	75.7	5.3	7.14	.001	.0005	.003
E-19	Mudstone, calcareous	OAP-493	3.4	1.3	74.6	8.7	11.56	.001	.0005	.004
E-18	Mudstone, calcareous	OAP-492	2.9	1.3	75.0	10.7	14.16	.001	.0005	.005
E-17	Chert	OAP-491	1.5	1.0	77.7	12.2	15.66	.0005	.0005	.006
E-16	Chert	OAP-490	3.5	3.3	95.3	15.7	16.71	.0005	.0005	.008
E-15	Chert	OAP-489	4.1	0.5	83.3	19.8	18.76	.0005	.0005	.010
E-14	Chert	OAP-488	3.2	0.7	90.2	23.0	21.00	.0005	.0005	.012
E-13	Chert	OAP-487	2.9	0.5	93.5	25.9	22.45	.0005	.0005	.013
E-12	Chert	FSH-486	5.0	0.6	93.3	30.9	25.45	.0005	.0005	.016
E-11	Chert	FSH-485	5.0	0.6	88.0	35.9	28.45	.0005	.0005	.018
E-10	Chert	FSH-484	5.0	0.5	86.7	40.9	30.95	.0005	.0005	.021
E-9	Chert	FSH-483	5.0	0.5	86.7	45.9	33.45	.0005	.0005	.023
E-8	Chert	FSH-482	5.0	0.5	85.2	50.9	35.95	.0005	.0005	.026
E-7	Dolomite and calcareous mudstone	FSH-481	3.2	0.3	50.7	54.1	36.91	.0005	.0005	.027
E-6	Chert	FSH-480	4.3	0.5	84.3	58.4	39.06	.0005	.0005	.029
E-5	Chert	FSH-479	5.0	0.6	82.3	63.4	42.06	.0005	.0005	.032
E-4	Chert, calcareous and mudstone	FSH-478	5.0	0.5	77.0	68.4	44.56	.0005	.0005	.034
E-3	Mudstone and limestone	FSH-477	3.5	0.5	76.2	71.9	46.31	.0005	.0005	.036
E-2	Mudstone and chert	FSH-476	5.0	0.6	81.7	76.9	49.31	.0005	.0005	.039
E-1	Mudstone, calcareous and chert	FSH-475	5.0	0.8	77.3	81.9	53.31	.001	.0005	.041
D member of Phosphoria formation										
D-12	Mudstone	OAP-474	3.3	1.0	76.0	3.3	3.3	.001	.001	.003
D-11	Mudstone	OAP-473	2.2	0.9	77.5	5.5	5.28	.002	.001	.006
D-10	Mudstone	OAP-472	1.2	1.5	74.7	6.7	7.68	.003	.001	.007
D-9	Mudstone	OAP-471	4.6	0.6	69.0	11.3	9.84	.002	.001	.011

Beds D-9 through D-12 are slumped and thicknesses may not be correct.

D- 6	Mudstone	OAP-470	2.0	2.2	71.7	13.3	14.24	.003	.001	.013
D- 7	Mudstone, calcareous	OAP-469	1.7	3.3	67.9	15.0	19.85	.003	.002	.017
D- 6	Mudstone	OAP-468	0.4	7.6	53.5	15.4	22.89	.003	.002	.018
D- 5	Phosphate rock	OAP-467	0.8	33.6	6.4	16.2	49.77	.010	.008	.024
D- 4	Mudstone	OAP-466	0.9	7.5	45.7	17.1	56.52	.005	.002	.026
D- 3	Mudstone, phosphatic	OAP-465	1.1	8.0	51.5	18.2	65.32	.007	.003	.029
D- 2	Phosphate rock	OAP-464	1.1	29.3	15.2	19.3	97.55	.008	.006	.036
D- 1	Mudstone	OAP-463	1.0	6.6	66.0	20.3	104.15	.004	.002	.038

C member of Phosphoria formation<sup>1</sup>

C-15	Sandstone	FSH-462	2.8	2.8	90.7	2.8	7.84	.001	.001	.003
C-14	Sandstone	FSH-461	5.0	2.1	92.9	7.8	18.34	.001	.001	.008
C-13	Sandstone	FSH-460	4.2	1.7	92.6	12.0	25.48	.001	.0005	.010
C-12	Sandstone	FSH-459	5.0	1.7	91.8	17.0	33.98	.0005	.0005	.012
C-11	Sandstone	FSH-458	5.0	1.7	92.7	22.0	42.48	.001	.0005	.015
C-10	Sandstone	FSH-457	2.6	2.1	91.0	24.6	47.94	.001	.001	.018
C- 9	Sandstone	FSH-456	5.0	2.2	90.7	29.6	58.94	.0005	.001	.023
C- 8	Sandstone	FSH-455	1.1	7.6	74.2	30.7	67.30	.002	.0005	.023
C- 7	Sandstone	FSH-454	3.9	2.4	83.8	34.6	76.66	.0005	.001	.027
C- 6	Chert	FSH-453	4.0	1.6	80.3	38.6	83.06	.0005	.001	.031
C- 5	Quartzite	FSH-452	1.2	2.0	89.0	39.8	85.46	.0005	.001	.032
C- 4	Dolomite, argillaceous	FSH-451	3.0	1.7	36.0	42.8	90.56	.0005	.0005	.034
C- 3	Limestone, sandy	FSH-450	3.5	0.2	32.2	46.3	91.26	.0005	.001	.037
C- 2	Limestone	FSH-449	5.0	0.0	16.3	51.3	91.26	.0005	.0005	.040
C- 1	Dolomite and calcareous sandstone	FSH-448	4.8	0.1	62.5	56.1	91.74	.001	.0005	.042

<sup>1</sup> It is doubtful that the full thickness of the C member was exposed at this locality.



## CENTENNIAL RANGE TRENCHES NOS. 2 AND 3, IDAHO. LOT NOS. 1254 AND 1255.

Phosphoria formation sampled in Centennial Range hand trenches nos. 2 and 3. Upper part of formation, lot no. 1255, sampled in trench no. 2, NW $\frac{1}{4}$  sec. 12, T. 14 N., R. 40 E.; lower part of formation, lot no. 1254, sampled in trench no. 3, NE $\frac{1}{4}$  sec. 7, T. 14 N. R. 41 E., Clark County, Idaho, at crest of range on southward-dipping homocline. Beds at trench no. 2 strike N. 65° W. and dip 14° SW., and beds at trench no. 3 strike N. 70° W. and dip 22° S. Section measured by F. S. Honkala and O. A. Payne and sampled by J. A. Kelleher and R. L. Konisecki in July 1948. Samples analyzed by U. S. Bureau of Mines Laboratory, Albany, Oregon.

Samples analyzed for eU and chem. U by the U. S. Geological Survey Laboratory, Geochemistry and Petrology Branch

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation										
Td-2	Mudstone, calcareous, sandy	--	0.5	--	--	0.5	--*	--	--	--*
Td-1	Mudstone and limestone	FSH-540	0.8	0.65	77.5	1.3	0.52	.001	--	.001
E member of Phosphoria formation, lot no. 1255										
E-12	Mudstone, sandy	FSH-539	5.0	1.0	81.1	5.0	5.00	.001	--	.005
E-11	Mudstone	FSH-538	5.0	1.1	81.5	10.0	10.50	.001	--	.010
E-10	Mudstone, sandy, calcareous	FSH-537	5.0	1.2	74.4	15.0	16.50	.001	--	.015
E-9	Mudstone and chert	FSH-536	0.9	1.3	89.0	15.9	17.67	.0005	--	.015
E-8	Chert	FSH-535	0.6	0.4	93.0	16.5	17.91	.0005	--	.016
E-7	Chert, argillaceous	FSH-534	2.2	0.4	92.5	18.7	18.79	.0005	--	.017
E-6	Chert, argillaceous	FSH-533	1.3	0.4	87.4	20.0	19.31	.0005	--	.018
E-5	Chert, argillaceous	FSH-532	3.8	0.6	89.5	23.8	21.59	.0005	--	.019
E-4	Chert, argillaceous	FSH-531	2.7	0.6	90.2	26.5	23.21	.0005	--	.021
E-3	Chert and mudstone	FSH-530	4.0	0.6	90.1	30.5	25.61	.001	--	.025
E-2	Mudstone	FSH-529	1.8	0.65	81.6	32.3	26.73	.001	--	.026
E-1	Mudstone	FSH-528	1.7	0.80	82.4	34.0	28.14	.001	--	.028
D member of Phosphoria formation, lot no. 1255										
D-12	Mudstone	OAP-527	0.9	0.8	86.5	0.9	0.72	.001	--	.001
D-11	Mudstone	OAP-526	1.6	1.0	81.5	2.5	2.32	.002	--	.004
D-10	Mudstone	OAP-525	3.0	1.05	80.7	5.5	5.47	.002	--	.010
Possible fault at top of D-9 indicated by gouge and breccia zone. No displacement apparent.										
D-9	Mudstone	OAP-524	3.2	1.6	80.3	8.7	10.59	.002	--	.016
D-8	Mudstone	OAP-523	2.2	1.1	77.1	10.9	13.01	.002	--	.021
D-7	Mudstone, calcareous	OAP-522	5.0	1.7	70.6	15.9	21.51	.003	--	.036
D-6	Phosphate rock	OAP-521	1.5	31.4	10.0	17.4	68.61	.011	.009	.052
D-5	Mudstone	OAP-520	0.7	5.4	66.0	18.1	72.39	.005	--	.056
D-4	Mudstone, calcareous and phosphate rock	OAP-519	1.4	9.65	52.3	19.5	85.90	.006	--	.064
D-3	Phosphate rock	OAP-518	0.7	34.5	4.3	20.2	110.05	.008	--	.070

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D- 2	Mudstone	OAP-517	1.7	2.8	74.4	21.9	114.81	.003	--	.075
D- 1	Phosphate rock, argillaceous	OAP-516	0.9	19.8	35.2	22.8	132.63	.009	--	.083

C member of Phosphoria formation, lot nos. 1255 and 1254

	Lot no. 1255									
C-10	Sandstone	FSH-515	1.6	3.2	87.1	1.6	5.12	.001	--	.002
C- 9	Sandstone	FSH-514	3.0	1.7	92.9	4.6	10.22	.0005	--	.003
C- 8	Sandstone, calcareous	FSH-513	2.6	1.3	76.2	7.2	13.60	.0005	--	.004
C- 7	Sandstone	FSH-512	5.0	1.7	85.7	12.2	22.10	.0005	--	.007
C- 6	Sandstone	FSH-511	5.0	2.8	85.3	17.2	36.10	.001	--	.012
C- 5	Sandstone	FSH-510	2.1	5.0	80.2	19.3	46.60	.002	--	.016
C- 4	Sandstone	FSH-509	5.0	3.7	77.0	24.3	65.10	.001	--	.021
C- 3	Sandstone, phosphatic	FSH-508	1.1	12.8	52.6	25.4	79.18	.007	--	.029
C- 2	Sandstone, calcareous	FSH-507	4.3	7.5	45.2	29.7	111.43	.004	--	.046
There is probably a gap of 10 feet or more between the lowest bed of lot no. 1255 and the highest bed of lot no. 1254.										
	Lot no. 1254									
C- 1	Chert	OAP-541	1.0	0.4	93.2	1.0	0.4*	.0005	.0005	.047

B member of Phosphoria formation, lot no. 1254

B- 2	Phosphate rock, argillaceous	OAP-506 <sup>1</sup>	1.7	22.8	34.1	1.7	38.76	.005	.008	.008
B- 1	Phosphate rock	OAP-505 <sup>1</sup>	4.6	32.4	8.4	6.3	187.80	.013	.011	.068

A member of Phosphoria formation, lot no. 1254

A- 7	Limestone and conglomerate	OAP-504	2.7	2.7	35.2	2.7	7.29	.001	.002	.003
A- 6	Limestone, argillaceous	OAP-503	4.8	1.5	47.2	7.5	14.49	.001	.000	.008
A- 5	Limestone, sandy, and calcareous sandstone	FSH-502	5.0	0.1	60.3	12.5	14.99	.001	.0005	.012
A- 4	Sandstone, calcareous	FSH-501	5.0	0.1	68.6	17.5	15.49	.001	.0005	.018
A- 3	Limestone, sandy, and calcareous sandstone	FSH-500	4.6	0.4	68.7	22.1	17.33	.001	.0005	.022
A- 2	Sandstone, calcareous	FSH-499	5.0	0.0	64.5	27.1	17.33	.002	.0005	.032
A- 1	Conglomerate, calcareous	FSH-498	2.1	0.2	56.0	29.2	17.75	.0005	.0005	.033

Quadrant formation

Cq-1	Sandstone, calcareous	FSH-497	4.4	0.3	61.0	4.4	1.32	.0005	.000	.002
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\* Cumulative data incomplete due to missing information.  
<sup>1</sup> See additional analyses at end of table.

Additional analyses of sample OAP-505<sup>2</sup>

Bed no.	Sample no.	P <sub>2</sub> O <sub>5</sub>	V <sub>2</sub> O <sub>5</sub>	F	SiO <sub>2</sub>	TiO <sub>2</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	MnO
B-1	OAP-505	33.93	0.03	3.63	4.83	0.008	49.84	0.11	1.18	0.22	0.008
		Ni	Cr <sub>2</sub> O <sub>3</sub>	Co	Zn	Cu	Pb	Ag	MoO <sub>3</sub>	Cl	Organic matter
		0.005	0.07	0.000	0.012	0.001	0.002	0.00004	0.002	0.008	0.24 <sup>3</sup>

<sup>2</sup> Analyses made by the U. S. Geological Survey, Geochemistry and Petrology Branch.  
<sup>3</sup> Co<sub>2</sub> and S reported present.